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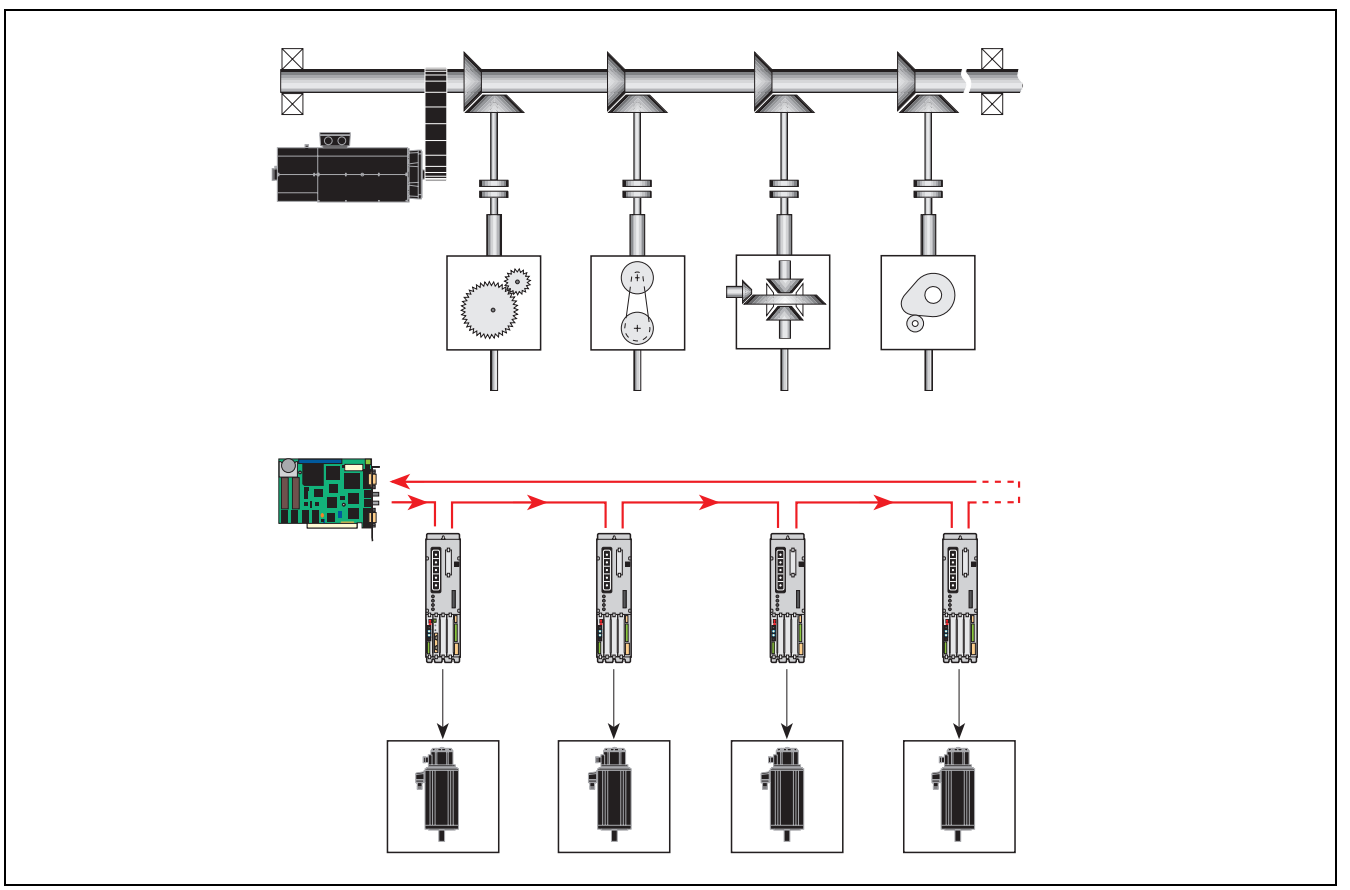

SYNAX
Decentralized System for the Synchronization of Machine Axes

Functional Description

Rexroth
Indramat

Title SYNAX Decentralized System for the Synchronization of Machine Axes

Type of documentation Functional Description

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This documentation serves to

- help familiarize the user with SYNAX
- familiarize the user with how to synchronize a sequential to a master axis
- select the applications required for the functions

Editing sequence

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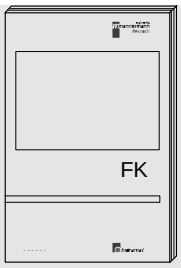

Functional Description:

Help familiarize the user with SYNAX
and the functions of SYNAX

Order designation:
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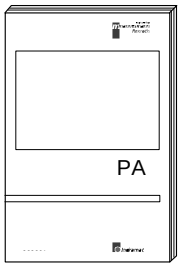

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Description of the SYNAX system parameters

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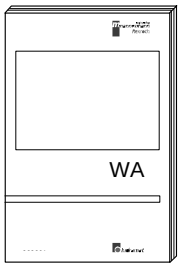

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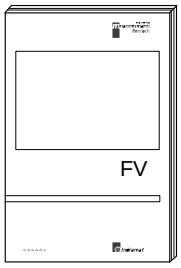

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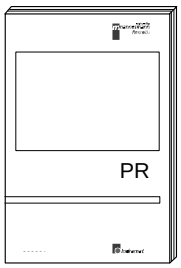

Project Planning:

Selection of units and hardware components
Basic control in cabinet construction

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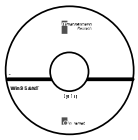
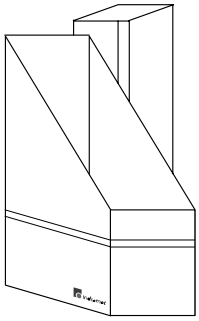


CD: SynTop

Collection of Windows help systems
SynTop, user interface for SYNAX

Order designation:
SWD-SYNTOP-INB-04VRS-MS-CD600



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1 Introduction

1.1 The SYNAX solution

Up until recently, the sychronization of axes of motion in such machinery as printing or textile machines has been realized with a mechanical longitudinal shaft and a variety of gears. However the constantly rising demands for greater precision and productivity, as well as reductions in cost, frequently cannot be satisfied with these concepts.

SYNAX, a decentralized system, offers the optimum technical and economic solution. The master axis and the following axis are hereby no longer mechanically but rather electronically coupled.

It is also possible, with SYNAX, to implement auxiliary and feed axes in the most ideal way.

Mechanical coupling with a main shaft

In a conventionally constructed machine, a main drive runs all printing units or cylinders of a printing machine over one main shaft. This results in a series of disadvantages:

- large-scale and expensive gearboxes are needed,
- precision is limited,
- disturbing torques of a cylinder affect the entire machine via the machine shaft,
- spurious oscillations as a result of low mechanical natural oscillations
- and very little flexibility.

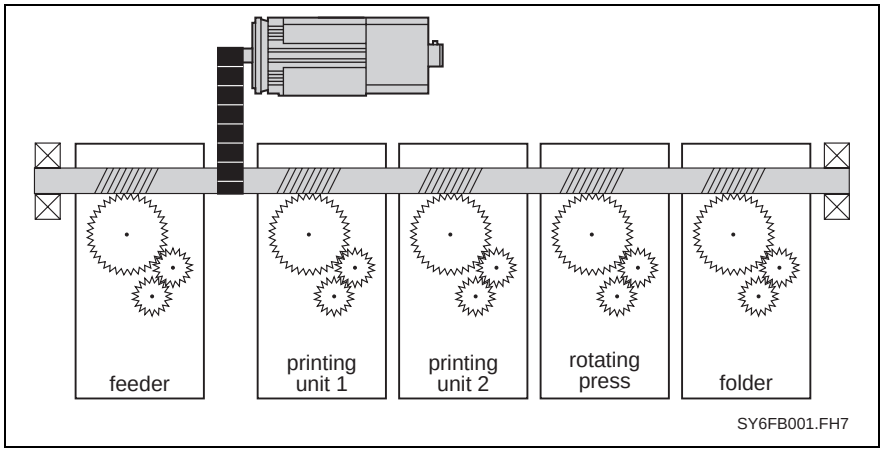


Fig. 1-1: Printing machine with main drive and one main shaft

Electronic coupling with SYNAX

The printing units or cylinders are coupled with an electronic shaft and individual intelligent digital drives. The CLC controller board produces the master axis signals in this case.

The printing units can be equipped in two different ways:

- with a partial electronic shaft, i.e., a real master axis and
- with a complete electronic shaft, i.e., a virtual master axis.

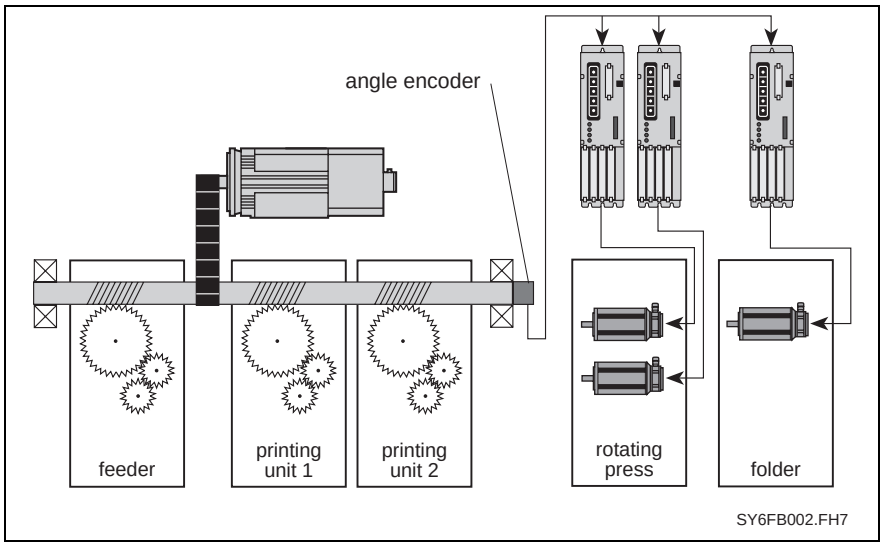


Fig. 1-2: A printing machine partially equipped with individual drives

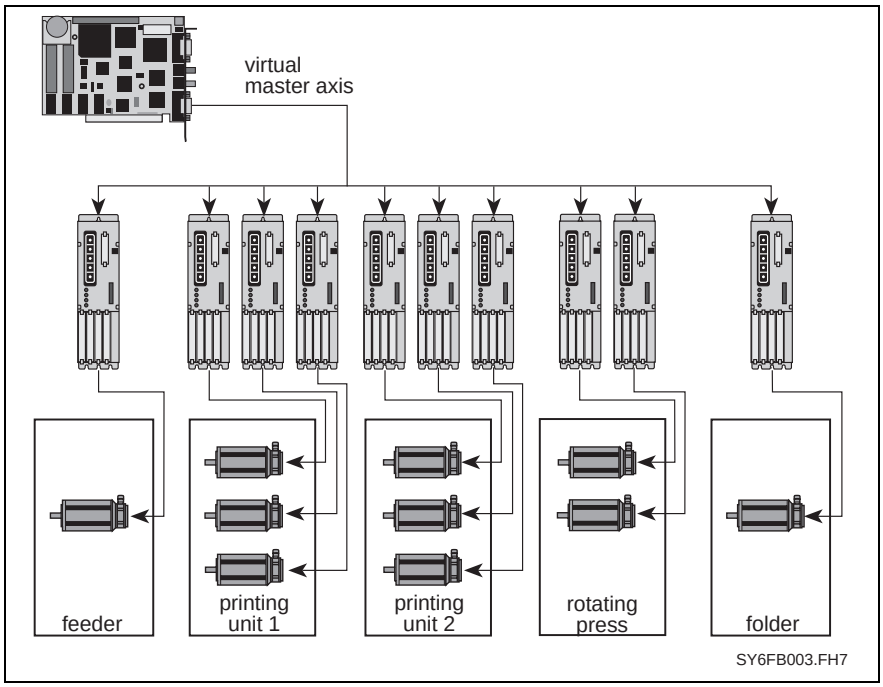


Fig. 1-3: A printing machine completely equipped with single drives

The decisive advantages of this solution:

- Costs are reduced because numerous mechanical parts have been eliminated.
- Higher precision and greater speed.
- Extreme flexibility.
- Energy consumption significantly reduced.
- No reactions from parasitic inductions such as cylinder bounce and folding blade.
- Expansion is no problem because of the modular construction.
- Potential savings in costs as machine components are modular.
- Individual printing units or cylinders can be switched on or off with great flexibility.
- A high level of synchronization precision of up to just under 0.005°, a high degree of synchronous operation with no lag error as well as drive-internal position control with a cycle time of 0.25 ms.
- No reactions of the machine to the disturbing torque of a cylinder.
- Practically no spurious oscillations from high mechanical natural frequencies.
- Minute settings of whole-number gearbox translations equal to from 1:65 000 to 65 000 : 1, speed ratios, longitudinal registers and so on.
- Printing units can be commissioned and tested individually.
- The modular construction makes it possible to interconnect up to 40 drives.
- Absolute angle encoder with a resolution of 1/2 000 000th revolution for the master axis.
- Simple parametrization makes it possible to easily adapt various machines and controllers.
- A comfortable diagnosis of all operating states as well as a rapid commission in the event of a problem.
- A broad spectrum of digital electronics for the drive, of highly dynamic motors, of interfaces for specific applications and of additional components.
- SYNAX solution for auxiliary and feed drives.

1.2 The range of SYNAX functions

Using SYNAX, it is possible to build machines which have no mechanical main shafts, couplings, drives, cams and so on.

Digital intelligent drives replace the mechanical gears, a fiber optics cable replaces the mechanical line shaft, while the CLC controller board replaces the function of the master axis.

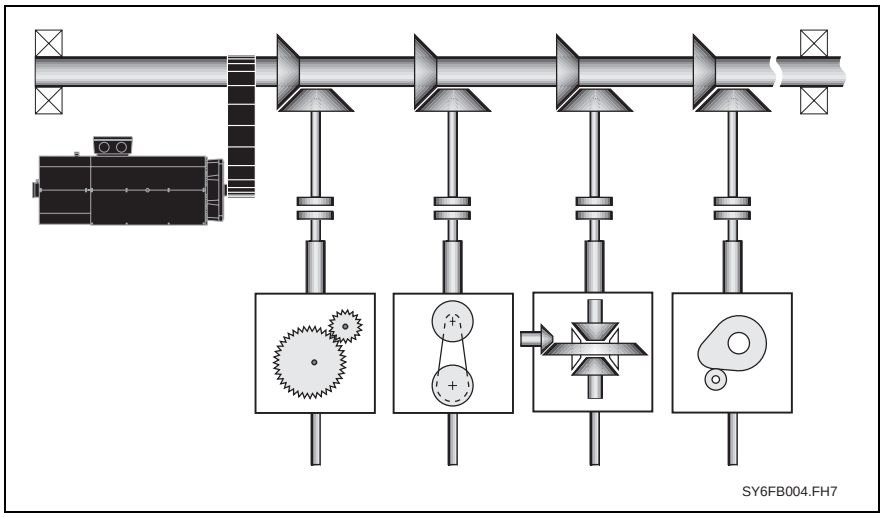


Fig. 1-4: Conventional machine construction with a mechanical line shaft

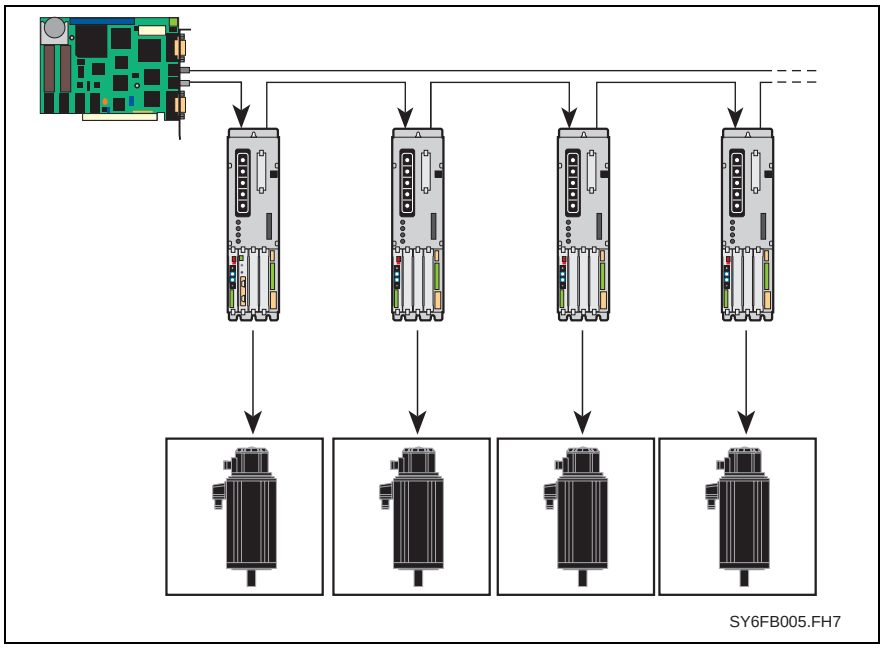


Fig.1-5: Machine construction with electronic line shaft and single digital drives

SYNAX offers the following functions to replace the gearbox:

- electronic gearbox - with phase synchronization
- electronic gearbox - with velocity synchronization
- electronic cam
- electronic pattern control

Electronic gearbox

The electronic gearbox with phase synchronization is equivalent to a differential gear with servo motor capable of being coupled. The gearbox transmission can be parametrized, the offset phase, i.e., the position of the servo motor, can be altered online.

The electronic gearbox with velocity synchronization, on the other hand, is equivalent to a PIV gear with servo motor for the transmission ratio. The base gearbox transmission can be parametrized and the gearbox transmission factor can be altered online.

Electronic cam

The electronic cam can be used in many versatile ways. In the simplest of applications, it reproduces a mechanical cam which translates rotating motion into linear motion. The geometry of the curve is stored in the drive in the form of a supporting point table. The phase offset of the cam with respect to the master axis, the offset of the linear axis as well as the stretching of the cam itself can all be altered online.

In addition, almost all laws of motion for the master and following axes can be preset. Areas of applications are, for example, rotay knives and intermittent feed units.

Electronic pattern controls

The electronic pattern controls can only be mechanically realized in a highly simplified version. In simple terms, it represents a basic cam in which segments of the cam were modified independent of each other. These electronic pattern controls are primarily used in textile machines.

Idle mode

In idle mode, the following axis is driven independently of the ELS master with a preset set.

Setup mode

In setup mode it is possible to position the following axis without regard to the ELS master axis.

In addition to these drive functions, SYNAX offers other functions which have, up until the present, been realized in separate control units. These are:

- master axis
- cam switch group
- winding control
- tension control
- register and inset control
- communications

Master axis

The function of the ELS master generally produces the position of the master axis in terms of the virtual master axis for which, as is the case with conventional drives, acceleraiton, speed and position can be preset. Alternatively, a high-resolution single-turn absolute encoder can aditionally be mounted to support a real master axis.

The function of the master axis also makes a series of status signals available, such as speed switching points, standstill, errors and so on.

Cam switch group

Using the cam switch group means various switches can be turned on and off dependent on the angular position of the ELS master axis.

Winding controls

The winding function for unwinding and winding up with central driven winders uses the master axis velocity and the winding velocity on the core (the actual speed of the winding motor) to calculate the current reel diameter.

In the design as *winding without sensor*

- this information is used to specify the torque of the winding drive via the lever bar in such a way that the web is winded up or down with a controlled tension.

In the case of a *winding control with dancer control*

- the tension is enforced via a dancer. The position of the dancer is controlled by the dancer controller.

Tension control

Tension control with load cell

controls dependent of the measured value of a load cell the tension to the desired command value.

In the case of a *dancer control*

- tension is enforced via a dancer. The position of the dancer is controlled by the dancer control.

Register and insetter control

The register and insetter control corrects any deviations between a register marker and the printing cylinder position and, for example, the position of a printing cylinder in terms of a desired variable.

I/O logic

The I/O logic implemented can be programmed. It can link external binary signals with such internal control and status signals as operating mode, ready signals, error messages and so on.

Analogue inputs

It is possible to set some parameters via analogue inputs.

Communication

Various interfaces and protocols are available for the communication with higher-ranking control units, e.g., PCs, PLCs or master computers.

CLC link

In complex machines, several motional controls are combined together in one control link (CLC link).

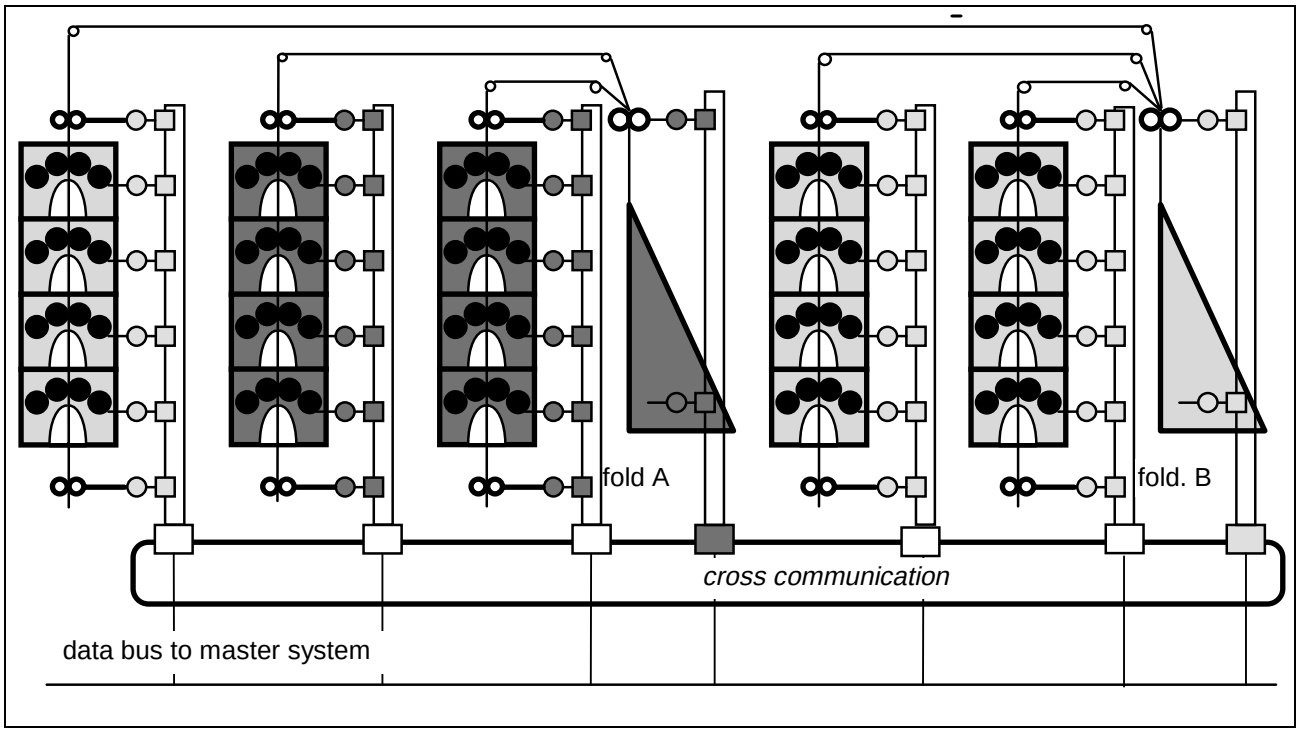


Fig. 1-6: CLC link in a newspaper printing machine

Each CLC is capable of calculating its own master axis position. Each drive in the link can be assigned to any master axis. The combining of the CLC controls uses the CLC plug-in card *DAQ*. The DAQ cards for the cross communications between the CLC controls are linked by a fiber optic cable link ring thus creating the CLC link.

Coupling via a doubled fiber optic cable ring ensures a one-error tolerance within the CLC link. The system tolerates the failure of a single motion control and the damaging of a fiber optic line between the DAQ modules.

1.3 The system components of SYNAX

SYNAX systems consist of up to 40 digital intelligent drives, a CLC-D or CLC-P plug-in controller board, a fiber optics cable connection between these components, which meets SERCOS interface standards, as well as a number of optional plug-in modules for the digital intelligent drives.

The digital intelligent drives are made up of drive controllers and their matching motors.

Drive controller

As drive amplifier, it is possible to use the DIAX03, DIAX04 or ECODRIVE family.

The program of the unit includes

- compact controllers up to 93 kW to supply power to single motors and
- modular units up to 35 kW for drive groups.

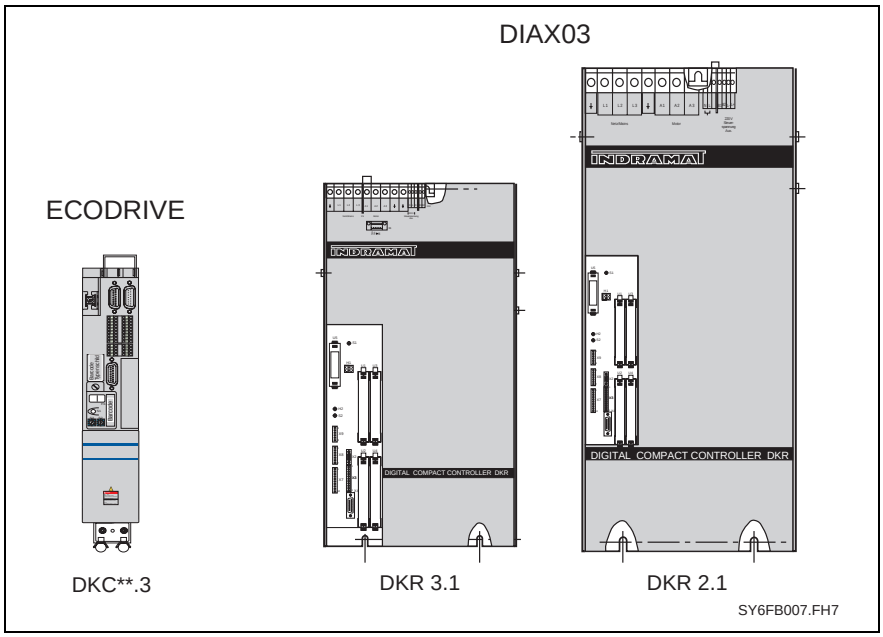


Fig. 1-7: Compact controller examples

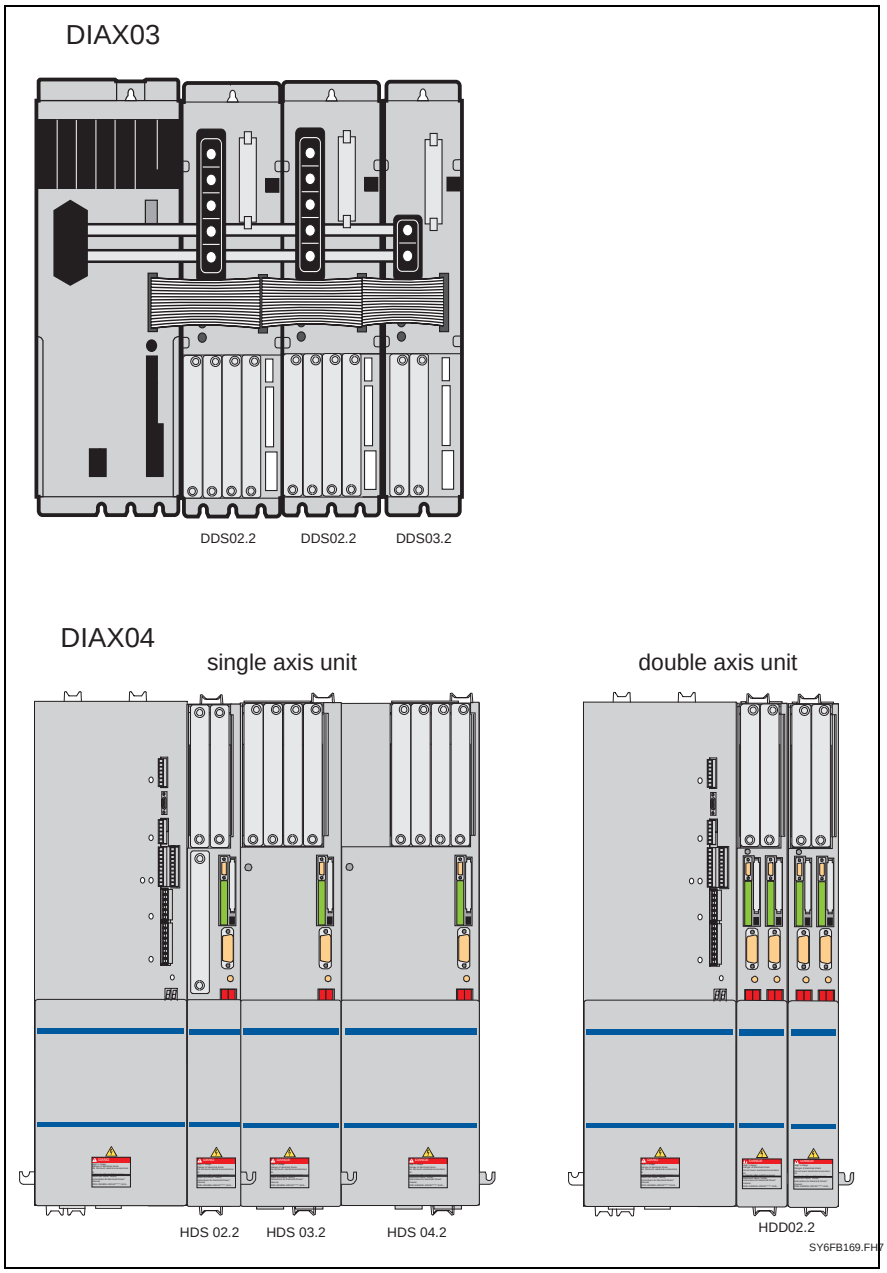


Fig. 1-8: Modular drive controller examples

The single axis unit family DIAX04 (HDS) and all units of the DIAX03 family are outfitted with 1 to 3 slots for optional additional plug-in modules.

In the double axis units HDD of the DIAX04 family and all ECODRIVE families, the slots are filled with the SERCOS interface DSS module.

Motors

The motor program includes mounting and assembly motors up to 93 kW.

Mounting motor	Kit motors
Synchronous motors 0.15 - 122 Nm Asynchronous motors up to 93 kW	Asynchronous motors up to 55 kW

Fig. 1-9: Power range of rotary motors

Either air or liquid cooling is available for almost every motor.

All rotary motors MKD/MKE, MDD/MHD, 2AD, 1MB, MBW, LAF and LSF linear motors can be used.

Fig. 1-10: Motor series

Plug-in modules

A series of plug-in cards (see Fig. 1-12) are available for all drive controllers. These ensure that drive and control tasks and demands are optimally met.

The CLC directly addresses the plug-in cards, assigned to the controller board, via the SERCOS interface. The drives thus fulfill two functions. In addition to their drive function, they are also a decentralized carrier for the control unit oriented plug-in cards (see Fig. 1-12).

Adapting to the hardware

Adapting the SYNAX system to the hardware of the relevant machine necessitates two steps:

- The drive concept with respect to motor, drive amplifier and the measuring system, i.e., basic drive configuration, must be determined.
- The plug-in cards allocated to the CLC controller functions and the CLC control unit must be determined.

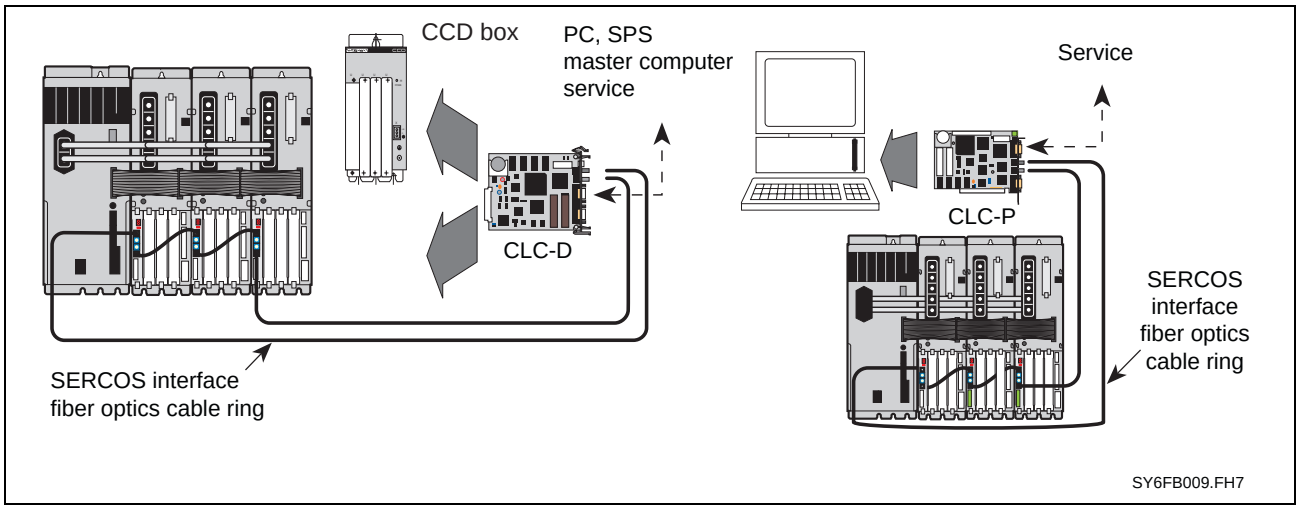


Fig. 1-11: CLC configurations

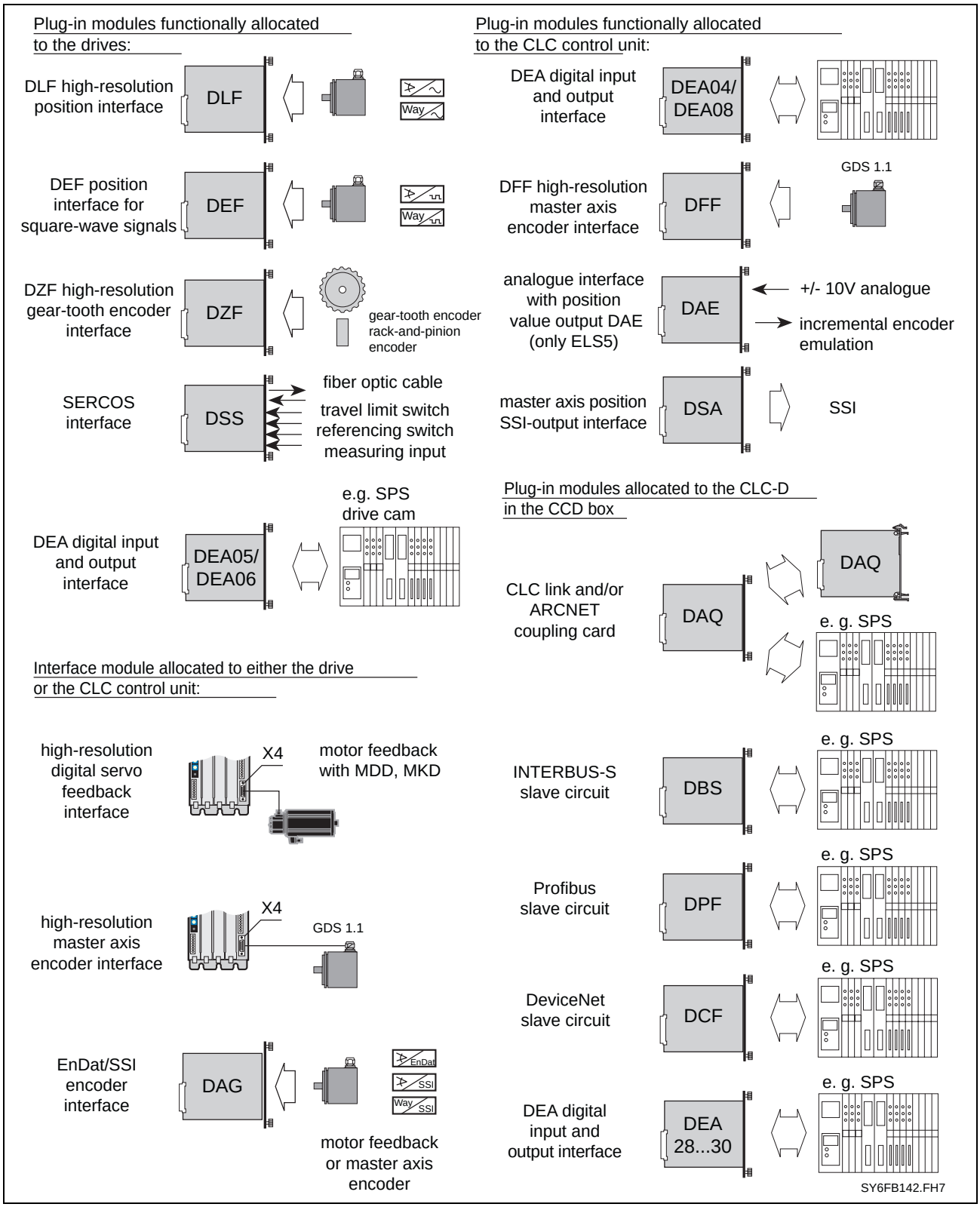


Fig. 1-12: Allocation by function of the plug-in cards to the drives and the CLC plug-in controller board in a SYNAX systems configuration.

1.4 SYNAX Reference List

Referenced firmware

Product:	Product firmware (order designation):	Printed board firmware (EPROM labelling):
CLC-P / CLC-D & CCD	FWA-CLC*DP-SY*-06VRS-MS	FWC-CLC*DP-SY*-06VRS-MS
CLC-D & CCD + Profibus	FWA-CLC*DP-SP1-06VRS-MS	FWC-CLC*DP-SY*-06VRS-MS FWC-DPF5.2-CP2-03VRS-NN
CLC-D & CCD + Interbus-S	FWA-CLC*DP-SS1-06VRS-MS	FWC-CLC*DP-SY*-06VRS-MS FWC-DBS3.1-CI1-02VRS-NN
CLC-D & CCD + DeviceNet	FWA-CLC*DP-SD1-06VRS-MS	FWC-CLC*DP-SY*-06VRS-MS FWC-DCF01*-CD1-01VRS-NN
CLC-D & drive family DIAX03	FWA-DIAX03-SY1-06VRS-MS	FWC-CLC*DP-SY*-06VRS-MS FWC-DSM2.3-ELS-05VRS-MS
Drive family DIAX03	FWA-DIAX03-ELS-04VRS-MS	FWC-DSM2.3-ELS-04VRS-MS
Drive family DIAX03	FWA-DIAX03-ELS-05VRS-MS	FWC-DSM2.3-ELS-05VRS-MS
CLC-D & Profibus drive family DIAX03	FWA-DIAX03-SP1-06VRS-MS	FWC-CLC*DP-SY*-06VRS-MS FWC-DPF5.2-CP2-03VRS-NN FWC-DSM2.3-ELS-05VRS-MS
CLC-D & Interbus drive family DIAX03	FWA-DIAX03-SS1-06VRS-MS	FWC-CLC*DP-SY*-06VRS-MS FWC-DBS3.1-CI1-02VRS-NN FWC-DSM2.3-ELS-05VRS-MS
CLC-D & DeviceNet drive family DIAX03	FWA-DIAX03-SD1-06VRS-MS	FWC-CLC*DP-SY*-06VRS-MS FWC-DCF01*-CD1-01VRS-NN FWC-DSM2.3-ELS-05VRS-MS
CLC-D & drive family DIAX04	FWA-DIAX04-SY1-06VRS-MS	FWC-CLC*DP-SY*-06VRS-MS FWC-HSM1.1-ELS-05VRS-MS
Drive family DIAX04	FWA-DIAX04-ELS-05VRS-MS	FWC-HSM1.1-ELS-05VRS-MS
CLC-D & Profibus drive family DIAX04	FWA-DIAX04-SP1-06VRS-MS	FWC-CLC*DP-SY*-06VRS-MS FWC-DPF5.2-CP2-03VRS-NN FWC-HSM1.1-ELS-05VRS-MS
CLC-D & Interbus drive family DIAX04	FWA-DIAX04-SS1-06VRS-MS	FWC-CLC*DP-SY*-06VRS-MS FWC-DBS3.1-CI1-02VRS-NN FWC-HSM1.1-ELS-05VRS-MS
CLC-D & DeviceNet drive family DIAX04	FWA-DIAX04-SD1-06VRS-MS	FWC-CLC*DP-SY*-06VRS-MS FWC-DCF01*-CD1-01VRS-NN FWC-HSM1.1-ELS-05VRS-MS
Ecodrive	FWA-ECODRV-SSE-02VRS-MS FWA-ECODRV-SSE-03VRS-MS	FWC-DKC2.1-SSE-02VRS-MS FWC-DKC2.1-SSE-03VRS-MS
Ecodrive03	FWA-ECODR3-SGP-01VRS-MS	FWC-ESM2.1-SGP-01VRS-MS
User interface SYNTOP	SWA-SYNTOP-INB-04VRS-MS-CD600-COPY	SWD-SYNTOP-INB-04VRS-MS-CD600

Fig. 1-13: Referenced firmware

Note: The software with suffix -COPY may be copied.

Supplementary documentation

Order text:	Title:
DOK-SYNAX*-SY*-06VRS**-FK01-EN-P	SYNAX - Functional Description
DOK-SYNAX*-SY*-06VRS**-PA01-EN-P	SYNAX - Parameter Description
DOK-SYNAX*-SY*-06VRS**-PR01-EN-P	SYNAX - Project Planning
DOK-SYNAX*-SY*-06VRS**-WA01-EN-P	SYNAX - Trouble Shooting Guide
DOK-SYNAX*-SY*-06VRS**-FV01-EN-P	SYNAX - Version notes
DOK-SYNAX*-SY*-06VRS**-4001-EN-P	SYNAX - Schuber 40-06V
SWD-SYNTOP-INB-04VRS-MS-D0600	General Support for SYNAX - Version 06VRS
DOK-DIAX03-ELS-05VRS**-50M1-EN-P	DIAX03 - Schuber 50-05V
DOK-DIAX04-ELS-05VRS**-60M1-EN-P	DIAX04 - Schuber 60-05V
DOK-ECODRV-SSE-03VRS**-57M1-EN-P	ECODRIVE - Schuber 57-03V
DOK-ECODR3-SGP-01VRS**-7201-EN-P	ECODRIVE03 - Schuber 72-01V

Fig. 1-14: Supplementary documentation

1.5 Adapting SYNAX to a machine

The hardware adaptation of SYNAX to a specific machine is achieved with the selection of the corresponding motor/drive combination, in particular with the already described plug-in cards.

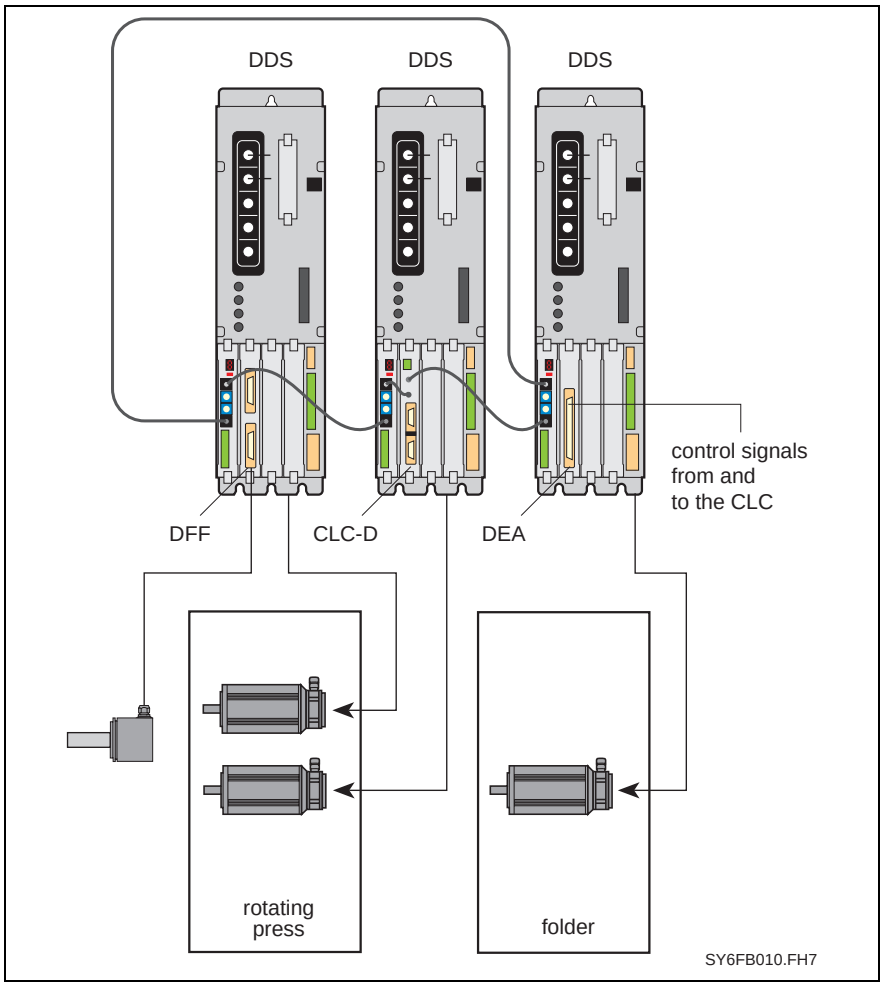


Fig. 1-15: Applications example of Fig. 1.2

All adaptation of the software is done almost exclusively with parameters. Axis-overreaching C and axis-related A, S and P parameters are available for this purpose. The CLC controller board centrally takes care of a conform parametrization of the entire SYNAX system (CLC and drives).

The individual axes and functions are controlled via binary inputs and outputs. With the aid of the I/O logic, these internal input and output signals are linked to external inputs and outputs. External I/Os are the DEA plug-in cards with 15 inputs and 16 outputs each, as well as memory in the dual port ram of the CLC-P or the CLC-D which can be accessed via a serial protocol such as Siemens 3965R or ARCNET.

The logic program is created in a textfile. It is loaded onto the CLC controller board in the form of a parameter list once it is compiled.

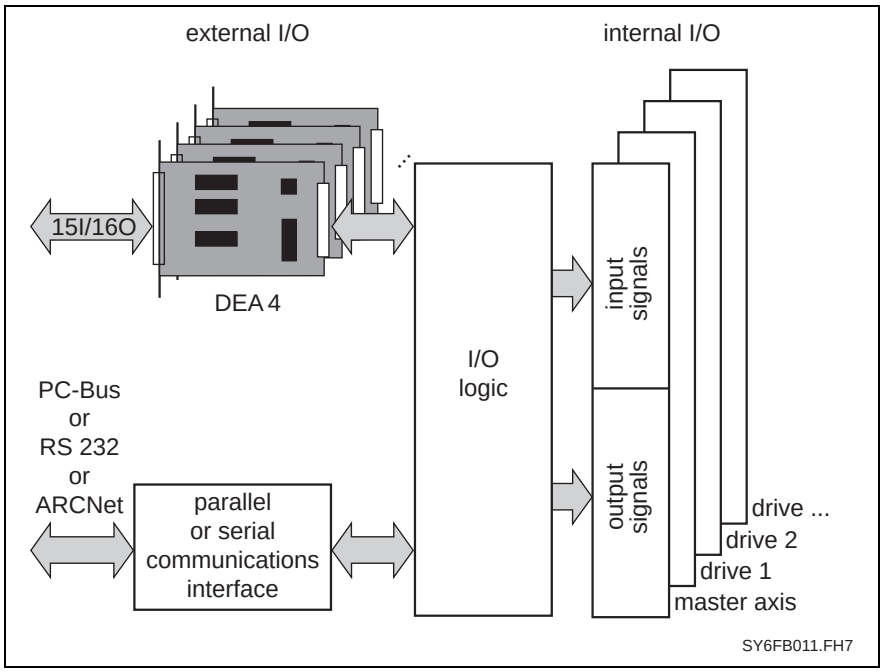


Fig. 1-16: I/O logic

1.6 Safety guidelines for control units

General information

These instructions must be read and understood before the equipment is used to minimize the risk of personel injury and / or property damage. Follow these safety instructions at all times.

If the product is resold, rented and / or otherwise transferred or passed on to others, these safety instructions must accompany it.

WARNUNG

Improper use of this equipment, failure to follow the attached safety instructions, or tampering with the product, including disabling of safety device, may result in personal injury, severe electrical shock, death, or property damage.

- Indramat is not liable for damages resulting from failure to observe the warnings given in these instructions.
- Operating, maintenance and safety instruction in the appropriate language must be ordered and received before initial start-up, if the instructions in the language provided are not understood perfectly.
- Proper and correct transport, storage, assembly and installation as well as care in operation and maintenance are prerequisites for optimal and safe operation of this equipment.
- Trained and qualified personnel:
  Only trained and qualified personnel may work on this equipment or in its vicinity. Personnel is qualified if they have sufficent knowledge of the assembly, installation, and operation of the product as well as of all warnings and precautionary measures noted in these instructions. Furthermore, they should be trained, instructed and qualified to switch electrical circuits and equipment on and off, to ground them, and to mark them according to the requirements of safe work practices and common sense. They must have adequate safety equipment and be trained in first aid.
- Use only spare parts approved by the manufacturer.
- All safety regulations and requirements for the specific application must be followed as practiced in the country of use.
- The equipment is designed for installation on commercial machinery.
- Start-up is only permitted once it is sure that the machine in which the products are installed complies with the requirements of national safety regulations and safety specifications of the application. European countries: see Directive 89/392/EEC (Machine Guideline).
- Operation is only permitted if the national EMC regulations for the application are met.
  The instructions for installation in accordance with EMC requirements can be found in the Indramat document "EMC in Drive and Control Systems".
  The machine builder is responsible for the adherence of the limiting values as prescribed in the national regulations and specific regulations for the application concerning EMC.
- Technical data, connections, and operational conditions are specified in the product documentation and must be followed.

Protection against contact with electrical parts

Note: This section pertains to equipment and drive components with voltages over 50 Volts.

Touching live parts with potentials of 50 Volts and higher applied to them can be dangerous and cause severe electrical shock. In order for electrical equipment to be operated, certain parts must have dangerous voltages applied to them.

Danger

High Voltage!

Danger to life, severe electrical shock and risk of injury

⇒ Only those trained and qualified to work with or on electrical equipment are permitted to operate, maintain and / or repair this equipment.

⇒ Follow general construction and safety regulations when working on electrical installations.

⇒ Before switching on power, the ground wire must be permanently connected to all electrical units according to the connection diagram in the Project Planning Manual.

⇒ At no time may electrical equipment be operated if the ground wire is not permanently connected, even for brief measurements or tests.

⇒ Before beginning any work, disconnect mains or the voltage source from the equipment. Lock the equipment against being switched on while work is being performed.

⇒ Wait 5 minutes after switching off power to allow capacitors to discharge before beginning work. Measure the voltage on the capacitors before beginning work to make sure that the equipment is safe to touch.

⇒ Never touch the electrical connection points of a component while power is turned on.

⇒ Before switching the equipment on covers and guards provided wih the equipment must be installed to prevent contact with live parts. Before operating cover and guard live parts properly so they cannot be touched.

⇒ A leakage current protective device must not be used for an AC drive! Indirect contact must be prevented by other means, for example, by an overcurrent protective device.
European countries: according to EN 50178/1994, section 5.3.2.3

⇒ Electrical components with exposed live parts must be installed in a control cabinet to prevent direct contact.
European countries: according to EN 50178/1994, section 5.3.2.3

Danger

High discharge current!

Danger to life, risk of severe electrical shock and risk of injury!

⇒ All units and the motors must be connected to a grounding point with the ground wire or must be grounded themselves before switching on power.

⇒ The discharge current is greater than 3.5 mA. A permanent connection to the supply system is therefore required for all units.
European countries: according to EN 50178/1994, section 5.3.2.3.

⇒ U.S.: See National Electrical Codes (NEC), National Electrical Manufacturers Association (NEMA), and local building codes. The user of this equipment must consult the above noted items at all times.

⇒ The ground wire must always be connected before start-up, even during the performance of tests. Otherwise, high voltages may be present at the unit housing, which can result in severe electrical shock and personal injury.

Protection by protective low voltage (PELV) against electrical shock

All connections and terminals with voltages ranging between 5 and 50 volts on Indramat products are protective low voltages designed in accordance with the following standards on contact safety:

- international: IEC 364-4-411.1.5
- European countries within the EU: see EN 50178/1994, section 5.2.8.1.

WARNUNG

High electrical voltages due to incorrect connections!

Danger to life and limb, severe electrical shock and / or serious bodily injury!

⇒ Only that equipment or those electrical components and cables may be connected to all terminals and clamps with 0 to 50 volts if these are of the protective low voltage type (PELV = Protective Extra Low Voltage).

⇒ Only connect those voltages and electrical circuits that are safely isolated. Safe isolation is achieved, for example, with an isolating transformer, an optoelectronic coupler or when battery-operated.

Protection against dangerous movements

Dangerous movements can be caused when units have bad interfaces or motors are connected incorrectly.

There are various causes of dangerous movements:

- Improper or incorrect wiring or cable connections
- equipment is operated incorrectly
- probe parameters or encoder parameters are set incorrectly
- broken components
- errors in software or firmware

Dangerous movements can occur immediately after equipment is switched on or even after an unspecified time of trouble-free operation.

Although the monitoring circuits in the drive components make improper operation almost impossible, personnel safety requires that proper safety precautions be taken to minimize the risk of electrical shock, personal injury and / or property damage. This means that unexpected motion must be anticipated since safety monitoring built into the equipment might be defeated by incorrect wiring or other faults.

Danger

Dangerous movements!

Danger to life, electrical shock and risk of injury or equipment damage!

⇒ In the drive component monitoring units, every effort is made to avoid the possibility of faulty operation in connected drives. Unintended machine motion or other malfunction is possible if monitoring units are disabled, by-passed or not activated.

⇒ Safe requirements of each individual drive application must be considered on a case-by-case basis by users and machine builders.

Avoiding accidents, electrical shock, personal injury and / or property damage:

⇒ Keep free and clear of the machine‘s range of motion and moving parts. Prevent people from accidentally entering the machine‘s range of movement:
- use protective fences
- use protective railings
- install protective coverings
- install light curtains

⇒ Fences should be strong enough to withstand maximum possible momentum.

⇒ Mount the Emergency Stop (E-Stop) switch in the immediate reach of the operator. Verify that the Emergency Stop works before start-up. Do not use if not working.

⇒ Isolate the drive power connection by means of an Emergency Stop circuit or use a safe lock-out system to prevent unintentional start-up.

⇒ Make sure that the drives are brought to standstill before accessing or entering the danger zone.

⇒ Disconnect electrical power to the equipment using a master lock-out and secure against reconnection for:
- maintenance and repair work
- cleaning of equipment
- long periods of discontinued equipment use

⇒ Avoid operating high-frequency, remote control, and radio equipment near equipment electronics and supply leads. If use of such equipment cannot be avoided, verify the system and the plant for possible malfunctions at all possible positions of normal use before the first start-up. If necessary, perform a special Electromagnetic Compatibility (EMC) test on the plant.

Protection against magnetic and electromagnetic fields during operations and mounting

Magnetic and electromagnetic fields in the vicinity of current-carrying conductors and permanent motor magnets represent a serious health hazard to persons with heart pacemakers, metal implants and hearing aids.

WARNING

Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electrical equipment!

⇒ Persons with pacemakers and metal implants are not permitted to have access to the following areas:
- Areas in which electrical equipment and parts are mounted, operating or are being commissioned.
- Areas in which parts of motors with permanent magnets are being stored, repaired or mounted.

⇒ If it is necessary for a person wearing a heart pacemaker to enter into such an area then a physician must be consulted prior to doing so.

⇒ Persons with metal implants or hearing aids must take care prior to entering into areas described above. It is assumed that metal implants or hearing aids will be consulted prior to doing so.

Protection during handling and installation

All Indramat products should be handled and assembled according to the instructions in the documentation.

CAUTION

Risk of injury caused by crushing, shearing, cutting, and thrusting movements!

⇒ Observe installation instructions and safety regulations before handling and working on the product.

⇒ Use suitable installation in using lifting or moving equipment. Refer to the user manual for the product.

⇒ Take precautions to avoid pinching and crushing.

⇒ Only use suitable tools specified in the user manuals and use them according the instructions.

⇒ Use lifting devices and tools correctly and safely.

⇒ Wear appropriate protective clothing, e.g., protective goggles, safety shoes, protective gloves.

⇒ Never stand under suspended loads.

⇒ Clean up liquids from the floor to prevent personnel from slipping.

Battery safety

Batteries contain reactive chemicals. Incorrect handling can result in injury or equipment damage.

CAUTION

Risk of injury due to incorrect handling!

⇒ Do not attempt to reactivate dead batteries by heating or other methods (danger of explosion and corrosion).

⇒ Never charge batteries (danger from leakage and explosion).

⇒ Never throw batteries into a fire.

⇒ Do not take batteries apart.

⇒ Handle carefully. Incorrect extraction or installation of a battery can damage equipment.

Note: Environmental protection and disposal! The batteries contained in the product should be considered as hazardous material for land, air, and sea transport in the sense of the legal requirements (danger of explosion). Dispose of batteries separately from other refuse. Observe the legal requirements in the country of installation.

2 Master axis and cam switch group

2.1 General information on the master axis

The position of the master axis can be specified by either a real or a virtual master axis.

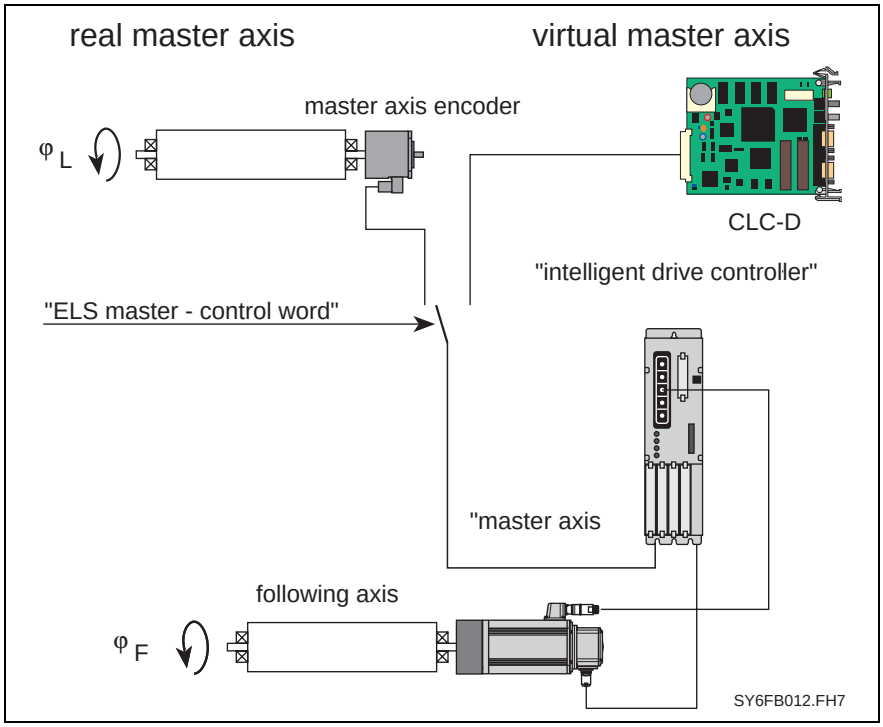


Fig. 2-1: The master axis functions

It is basically irrelevant for the functioning of the following axis whether it synchronizes with a real or a virtual master axis.

A virtual master axis does, however, have the following advantages in comparison to a real master axis:

- the main shaft angular encoder is not needed
- greater running smoothness and more precise synchronism
- acceleration and deceleration can be precisely defined

Note: One master axis revolution should basically equal one machine cycle. One machine cycle corresponds, for example, to one extrusion of a print format of a printing machine.

2.2 Real master axis

The function of the real master axis

The movement of a following axis can be synchronized with that of a real master axis. This requires the mounting of an angle encoder onto the relevant master axis. Suitable encoders are listed in the "SYNAX project planning" (DOK-SYNAX*-SY*-06VRS**-PR01-EN-P).

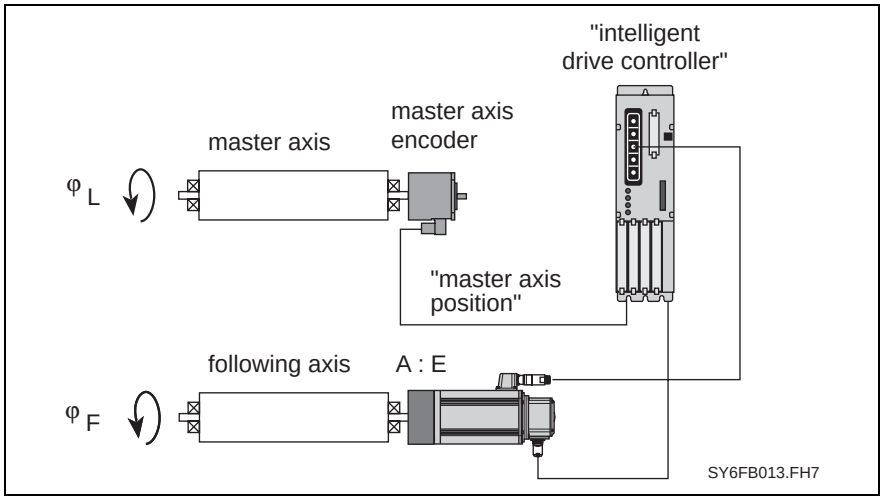


Fig. 2-2: Real master axis with one following axis

The master encoder is connected to an encoder interface (ref. DOK-SYNAX*-SY*-06VRS**-PR01-EN-P). The encoder interface may be an optional plug-in module (drive families DIAX03, DIAX04) or an additional on-board interface (ECODRIVE).

The evaluation of the master encoder may be configured for any following axis in the system.

The master axis position is cyclically read by the CLC via the SERCOS interface. The position value is extrapolated linearly and transmitted to all following axes simultaneously.

The CLC is notified of the location of the encoder interface by means of the parameter "real master - encoder drive address" (C-0-0005). The drive address must be input.

There is no external signal to activate this master axis function. The CLC starts working with the master axis as soon as the system is in operating mode.

Electronic measuring gear

The master axis establishes the reference of a following axis to a product, e.g., printing format. That is why *one master axis rotation* should always equal *one machine cycle*. It is often not possible to locate a suitable mounting position for a master axis encoder that meets this demand. In this case an electronic measuring gear can be used. This gear is then programmed so that one rotation at the gear output equals one product cycle.

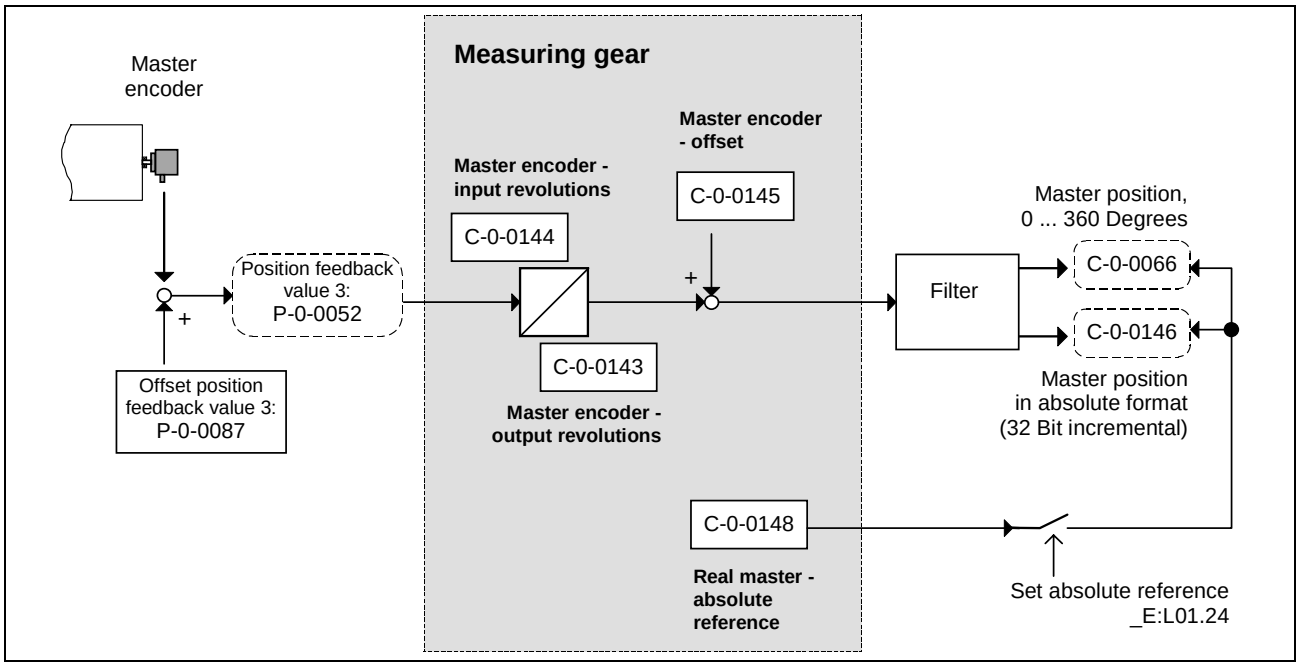


Fig. 2-3: Electronic measuring gear

Note: The electronic measuring gear is drive-supported as of firmware ...-**ELS-05V16** (DIAX03, DIAX04) and ...-**SGP-01V09** (ECODRIVE).

Measuring gear

The electronic measuring gear is drift-free. The "master encoder - input revolutions" (C-0-0144) and "master encoder - output revolutions" (C-0-0143) can be changed at any time.

If the gear values of the real master axis are altered while at standstill, then the master axis position will not change immediately. The new master axis position is not re-calculated until the next start-up.

If the ratio is altered while the real master axis is turning, then a new master axis position is re-calculated immediately. No jump occurs in the master axis position, but the master axis velocity (C-0-0067) does change.

Note: By changing the measuring gear, the absolute reference between "position feedback value 3" (P-0-0052) and master axis position is lost. It can be re-established with binary input "real master - set absolute measuring" (_E:L01.24).

Master axis position

Display formats

The master axis position (C-0-0066) displays the position within one revolution in terms of 0° to 360°.

The "ELS master - actual position value absolute format" (C-0-0146) specifies the position within 4096 revolutions. This position is displayed in a 32 bit format (incremental). The value specified in bits 0 to 20 equals the master axis position (C-0-0066); while bits 21 to 31 contain the revolutions.

Reference

A master axis position in absolute format makes it possible to have reference positions that exceed 360 degrees. If a multiturn encoder, e.g., a GDM, is used as a master axis encoder, then this master axis position is unequivocally within 4096 revolutions. A rotation of the real master axis of a maximum of $\pm$ 2047 revolutions is detected upon switch-over into the operating mode. This is taken into account when calculating the start value.

If a single-turn encoder is used, e.g., GDS, then the position is only unequivocal within *one* revolution. The number of revolutions in C-0-0146 is uncertain.

Offset

An offset between "actual position value 3" (P-0-0052) and the master axis position can be specified ahead of the resolver gearbox with "offset position feedback value 3" (P-0-0087) or after it with "master encoder - offset" (C-0-0145).

Establishing the absolute master axis position

Using "set absolute dimension" the master axis position (C-0-0066 and C-0-0146) can be set to a position pre-selected with parameter "real master - absolute reference" (C-0-0148).

"Set absolute dimension" is activated with the binary input "set absolute dimension" (_E:L01.24).

For reasons of precision, the absolute dimension should be set while the real master axis is standing still.

The binary output "acknowledge set absolute dimension" (_A:L01.24) signals that the master axis position relates to the absolute dimension.

Actual value smoothing

A filter of higher order is used to smooth the signal of a real master axis encoder. The signal noise on the master axis speed is filtered and periodic interference can be damped.

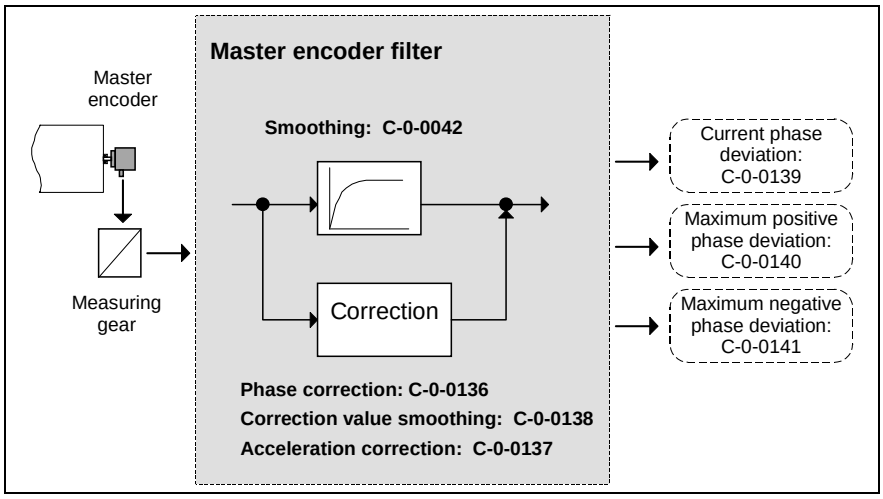


Fig. 2-4: Master axis filter of the real master axis

The filter time constant is set with parameter "real master - actual value smoothing time constant" (C-0-0042).

The correction parameters C-0-0136, C-0-0137 and C-0-0138 are used to minimize phase offset between input and output signals of the filter.

Note on adjusting the filter parameters

SynTop, the commissioning tool, is used to set the filter parameters. An oscilloscope is also needed. In the SynTop dialog "Real master axis: actual value smoothing" the parameters can be changed. The phase deviations (C-0-0139, C-0-0140, C-0-0141) are cyclically displayed in the dialog.

The master axis velocity is monitored with the oscilloscope. The analog output of a drive controller is used for this.

The parameters are programmed in two steps:

- The filter to smooth master axis velocity is set in the first step.
- The smoothing filter generates an offset between the measured encoder position and the master axis position at the output of the filter. This phase offset is minimized in the second step with the help of the correction parameter.

Smoothing the master axis velocity

The actual value smoothing uses filter time constant (C-0-0042). The start value is a low value, e.g., 50ms.

The setting is conducted at a constant but low master axis velocity. While monitoring the velocity on the oscilloscope, the time constant is increased until the signal is sufficiently smoothed.

The setting thus found is then checked and possibly optimized, with two to three velocities over a mean and a high velocity range.

The correction parameters are not altered in the first step. They are permanently set to the following values:

- Acceleration correction = 100 %
- Phase correction = 2 %
- Correction value smoothing = 15 ms

Correcting a phase shift

In the second step, the position offset between the measured (real) and the smoothed master axis signal is minimized. The correction parameters are used for this.

In addition to monitoring the master axis velocity during the optimizing process, it is also necessary to monitor any phase offset. Since phase offsets are not generated in the form of an analog signal, it is visualized via the diagnosis parameters in the SynTop dialog. The current phase deviations (C-0-0139) as well as maximum deviation in positive and negative directions (C-0-0140, C-0-0141) are cyclically displayed in the SynTop dialog. The maximum values must be set to zero prior to taking each measurement.

It generally suffices to optimize phase correction (C-0-0136) and smoothing correction (C-0-0138). Acceleration correction (C-0-0137) generally retains ist standard value of 100%.

Optimization takes place at constant master axis velocity. Phase correction is slowly increased which means that the phase offset decreases. The signal noise is increased by switching phase correction onto the master axis signal. The smoothing correction counteracts this interference. It is necessary to set the smallest possible value since smoothing correction influences the phase position of the correction.

To achieve an optimum setting, take measurements at various velocities.

In conclusion, check phase offset when running up and when braking.

Monitoring master axis position

When monitoring the master axis, any change in the position of the master axis is recognized

- when the system is switched on and
- when the input "RM position monitoring enable" is set.

The monitoring function is performed **once** each time the machine is switched on. As part of the procedure, the most recently stored position is compared with the first actual position value read. The maximum permissible deviation is determined in parameter "real master - position window" (C-0-0025). If the current master axis position deviates from the last one stored by a value greater than is permitted, then output "real master moved" (_A:L01.08) is set to 1.

The message "real master moved" (_A:L01.08) is buffered until the higher-ranking system, e.g., PLC, acknowledges. This also applies if the machine is switched off when it is in an error state. It is acknowledged by setting the input "real/virt. Master - clear error" (_E:L01.16). Output "real master moved" (_A:L01.08) is also cancelled by the CLC when input "real/virt. Master - clear error" (_E:L01.16) is set.

Monitoring can otherwise again be activated by setting input "RM position monitoring enable" (_E:L01.15).

As long as this input is set, then output "real master moved" (_A:L01.08) is set, if the real master axis is located outside of the position window.

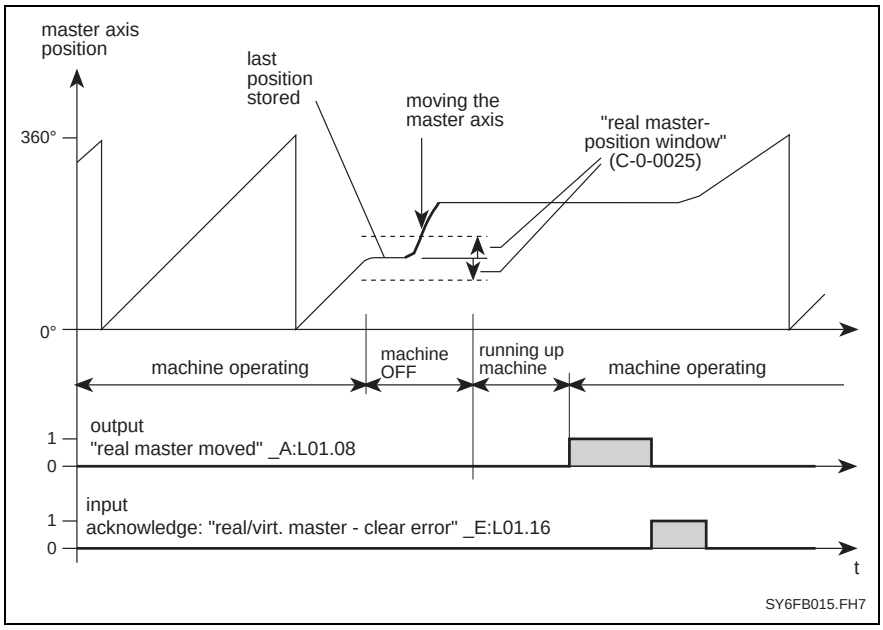


Fig. 2-5: Real master axis: monitoring the master axis position

Monitoring the master axis encoder

A second, redundant encoder is mounted to the main shaft to monitor the master axis encoder:

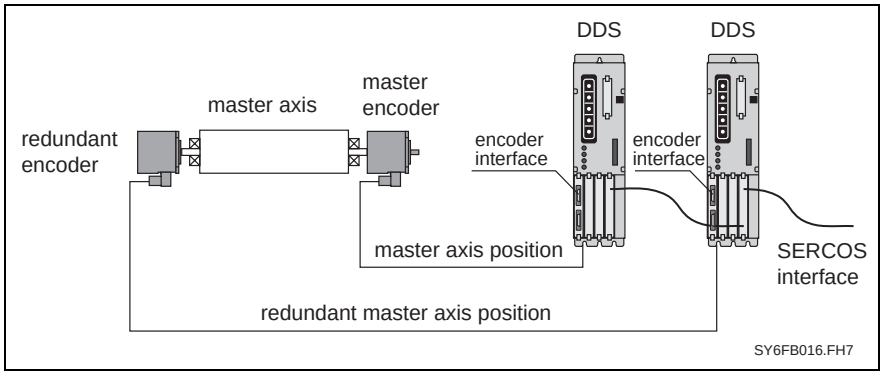


Fig. 2-6: Real master axis with redundant encoder

Both encoders are connected to any two drives. The addresses of the respective drives are entered in parameter "real master - encoder drive address" (C-0-0005) and "real master - redundant encoder drive address" (C-0-0072). Set in parameter "ELS master - control word" (C-0-0004) whether the encoders will work in the same or opposite direction.

Master axis encoder monitoring is automatically activated if a valid drive address is entered in parameter "real master - redundant encoder drive address" (C-0-0072).

The CLC cyclically reads both actual position values and generates the absolute position difference. This difference is compared to a maximum permissible deviation. The permissible deviation is set in parameter "real master - redundant encoder monitoring window" (C-0-0073).

Note: As long as the maximum permissible deviation is not exceeded, the real master axis will continue to follow the master encoder.

If the position difference is outside of the monitoring window, then the leading encoder is switched into. The CLC sets the outputs "virtual / real master error" (_A:L01.03) and "real master axis - redundant encoder error" (_A:L01.02). Until the error is cleared, the master axis will continue to run with the actual value of the encoder which was acknowledged as leading at the time the error occurred.

Note: Inputting "real/virt. Master - clear error" (_E:L01.16) will always switch into the master encoder.

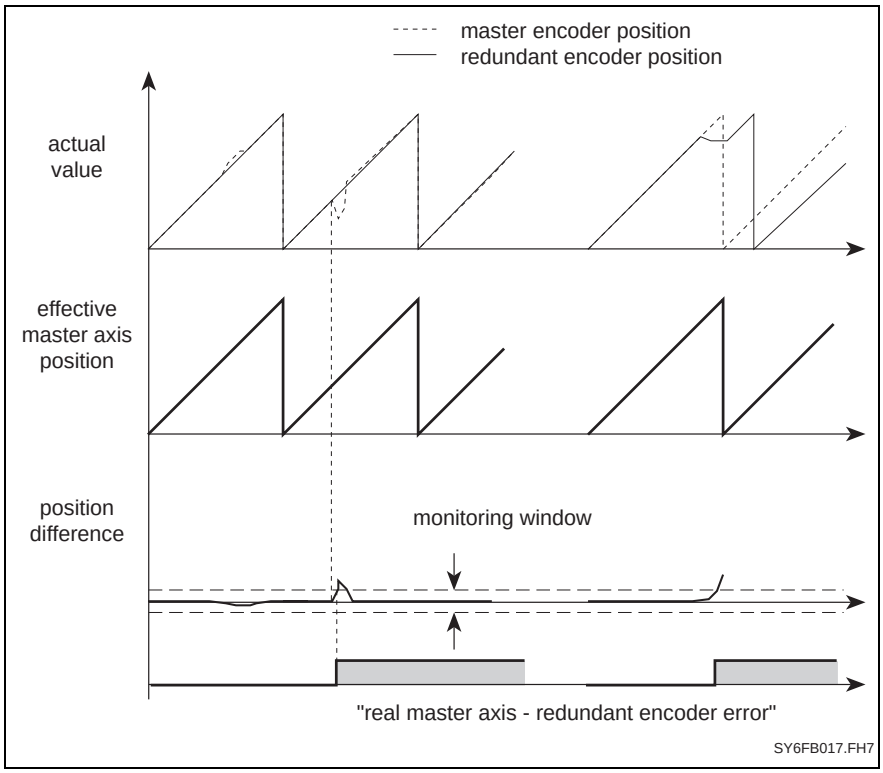


Fig. 2-7: Real master axis: monitoring master axis position

An error remains set until it is acknowledged ("real/virt. Master - clear error", _E:L01.16). It is not even automatically cleared once the position difference again is located within the monitoring window.

The peak value of the position difference is displayed in parameter "real master - redundant encoder max. position difference" (C-0-0074) for use with diagnostics and as an auxiliary value for the parametrization of the monitoring window.

Binary I/Os of the real master axis

Binary inputs of the real master axis

Designation	Function
_E:L01.15	RM position monitoring enable
_E:L01.16	Real/virt. Master - clear error
_E:L01.23	Real master - set absolute reference
_E:L01.24	Real master - set absolute measuring

Fig. 2-8: Binary inputs of the real master axis

Binary outputs of the real master axis

Designation	Function
_A:L01.02	RM redundant encoder error
_A:L01.03	Virtual/real master error
_A:L01.08	Real master moved
_A:L01.09	Real master positive direction
_A:L01.10	Virtual/real master standstill
_A:L01.23	Real master - set absolute reference acknowledge
_A:L01.24	Real master - set absolute measuring acknowledge
_A:L01.25	ELS master command value additive achieved

Fig. 2-9: Binary outputs of the real master axis

Rotational direction

The current direction of the master axis is signalled via output "real master positive direction" (_A:L01.09). Positive velocity equals status "1".

Standstill message

If master axis velocity drops below the value in "real master - standstill window" (C-0-0003), then output "virtual/real master standstill" (_A:L01.10) is set.

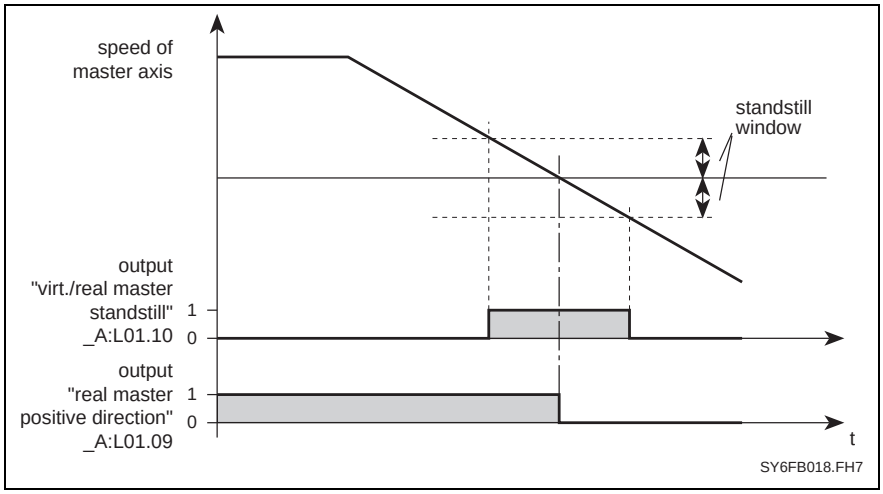


Fig. 2-10: Real master axis: standstill message and rotational direction

Parameters for the real master axis

Below is a list of all CLC systems parameters needed to run the real master axis.

(For details see "SYNAX Parameter Description", DOK-SYNAX*-SY*-06VRS**-PA01-EN-P.)

Parameter number	Designation
C-0-0003	Real master - standstill window
C-0-0004	ELS master - control word
C-0-0005	Real master - encoder drive address
C-0-0025	Real master - position window
C-0-0042	Real master - actual value smoothing time constant
C-0-0052	ELS master - speed operating points
C-0-0066	ELS master - actual position value
C-0-0067	ELS master - actual speed value
C-0-0072	Real master - redundant encoder drive address
C-0-0073	Real master - redundant encoder monitoring window
C-0-0074	Real master - redundant encoder maximum position difference
C-0-0136	Real master - phase correction
C-0-0137	Real master - acceleration correction
C-0-0138	Real master - correction value smoothing time constant
C-0-0139	Real master - actual phase deviation
C-0-0140	Real master - maximum positive phase deviation
C-0-0141	Real master - maximum negative phase deviation
C-0-0143	Master encoder - output revolutions
C-0-0144	Master encoder - input revolutions
C-0-0145	Master encoder - offset
C-0-0146	ELS master - actual position value absolute format
C-0-0148	Real master - absolute reference
C-0-0149	ELS master command value additive
C-0-0150	ELS master command value offset speed
C-0-0161	ELS master command value additive - positive limit
C-0-0162	ELS master command value additive - negative limit
A-0-0159	ELS master command value additive selection
P-0-0052	Position feedback value 3 (for diagnostics only)
P-0-0053	Lead drive position
P-0-0059	SSI-emulator-resolution
P-0-0087	Offset position feedback value 3
P-0-0108	Leed drive polarity
only with FWA-DIAX03-ELS04VRS-MS:	
P-0-0076	Interface position feedback value 3
P-0-0077	Position feedback 3 type parameter
only with FWA-DIAX03-ELS05VRS-MS FWA-DIAX04-ELS05VRS-MS FWA-ECODR3-SGP-01VRS-MS:	
S-0-0115	Position feedback 2 type parameter
P-0-0185	Function of external encoder

Fig. 2-11: Parameters of the real master axis

2.3 Virtual master axis

Functions of the virtual master axis

In systems with no real master axis, the virtual master axis fulfills the purpose of generating arithmetic master axis positions. The master axis position is calculated in a modulo format, a range of 0° to 360°, and cyclically transmitted to the drives.

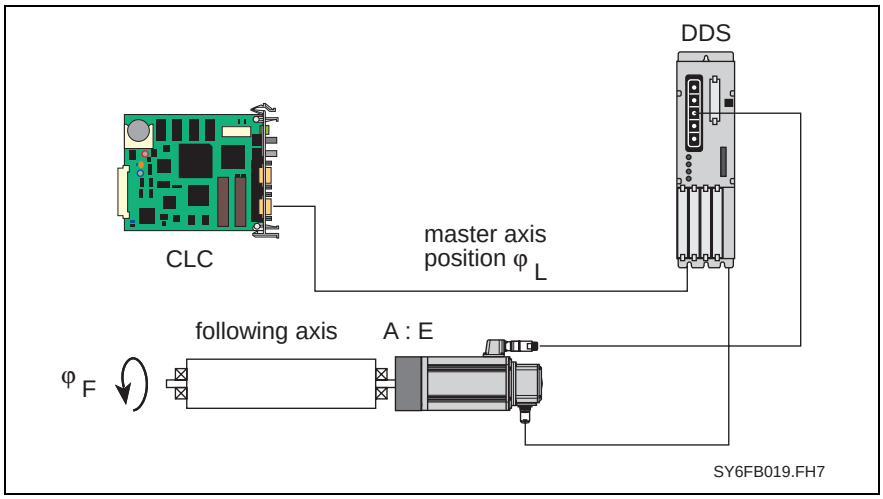


Fig. 2-12: Virtual master axis with one following axis

Operating states

The virtual master axis is controlled with binary inputs. The following figure depict the various operating states of the master axis dependent on the binary inputs:

"enable" = virtual master - enable"

"stop" = "VM stop position 1 active" or "VM stop position 2 active"

"E-stop" = "virtual master - E-stop"

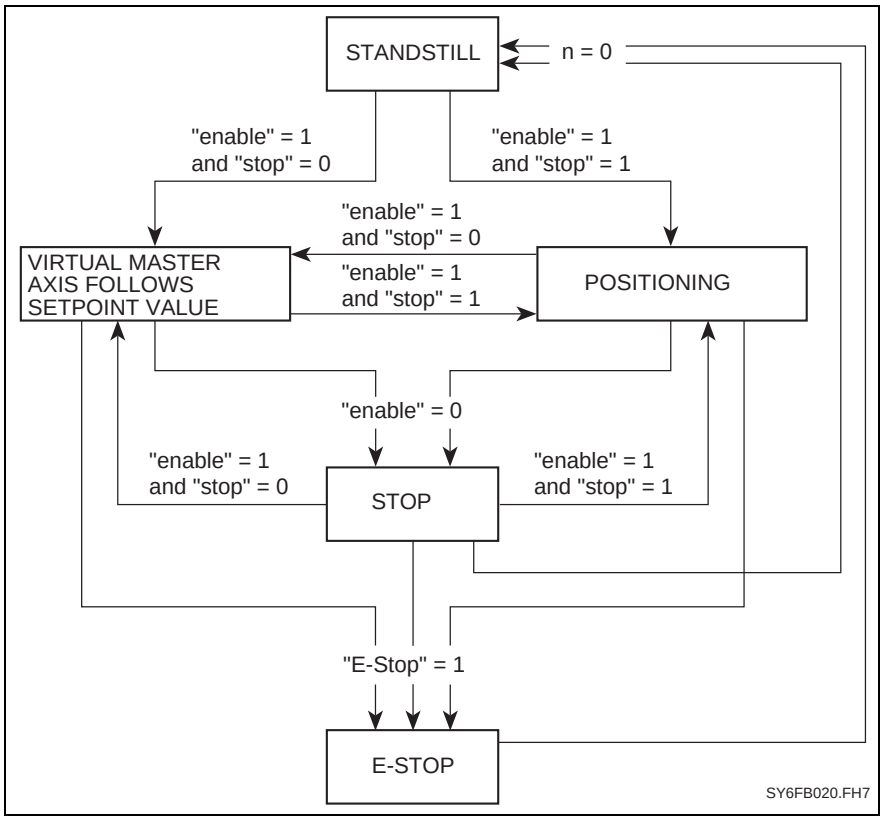


Fig. 2-13: Operating states of the virtual master axis

State	Movement initiated
STANDSTILL	master axis velocity = 0
VIRTUAL MASTER AXIS FOLLOWS VELOCITY COMMAND VALUE	In the simplest case, the virtual master axis always follows the current speed command value (see "Basic function", page 2-13). The binary inputs for activating a stop position are not used.
STOPPING	The master axis brakes until standstill with "virtual master - deceleration" (C-0-0009). No stop position is approached.
POSITIONING	The master axis moves to a selected stop position (see "Positioning", page 2-15).
E-STOP	The master axis brakes until standstill with "virtual master - emergency stop deceleration" (C-0-0010). No stop position is approached.

Fig. 2-14: Operating states

Basic function

The virtual master axis is enabled with the input signal "virtual master enable" (_E:L01.06). As long as this signal is applied, position setpoint values are generated and cyclically transmitted to the following axes.

If no stop position is active (see "Positioning", page 2-15), then the master axis will continue to adhere to the speed command value.

It is possible to program different ramps for velocity changes and master axis braking. The parameter "virtual master - bipolar acceleration" (C-0-0008) is active when accelerating the master axis, when approaching a stop position, and when changing setpoint values.

The ramp for decelerating to a standstill is set with the parameter "virtual master - deceleration" (C-0-0009). This parameter is activated when the master axis is stopped by cancelling the input "virtual master enable" (_E:L01.06).

If the signal "virtual master enable" (_E:L01.06) is again set when decelerating to a standstill, then the master axis will accelerate to the current speed command value (C-0-0006 or C-0-0054).

The acceleration change is limited by the parameter "virtual master - bipolar jerk" (C-0-0077). The jerk limit affects both the "virtual master - bipolar acceleration" (C-0-0008) and the "virtual master - deceleration" (C-0-0009).

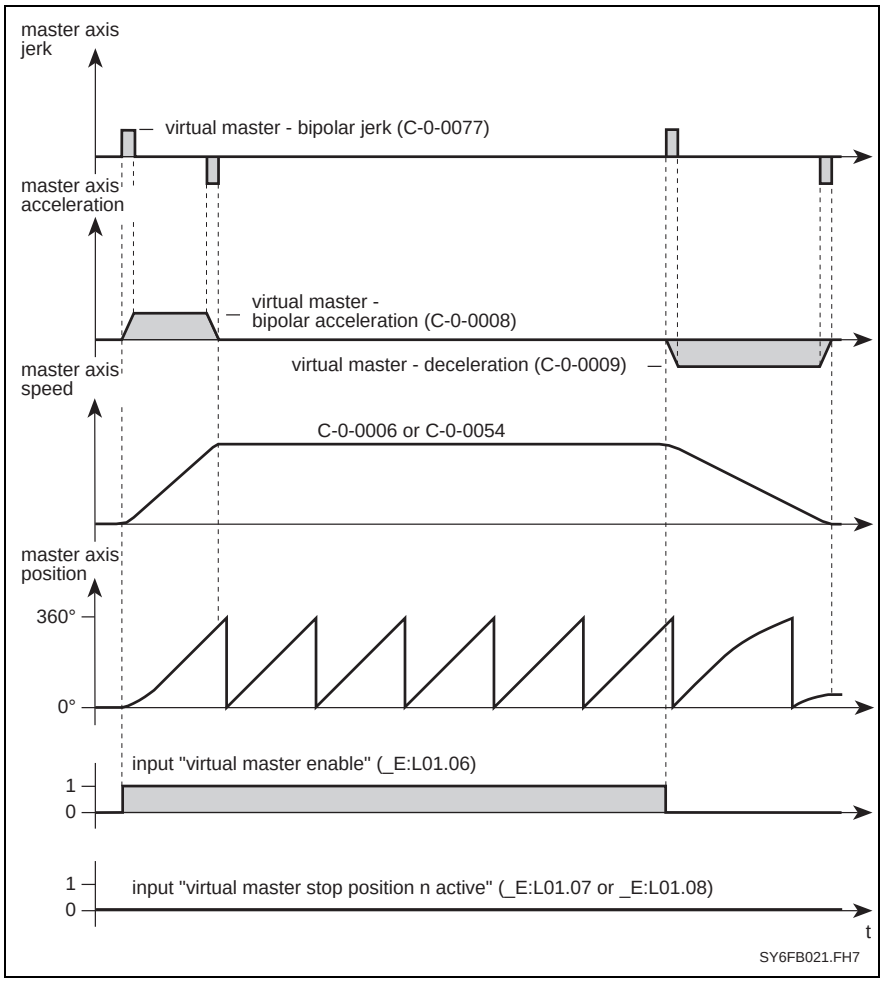


Fig. 2-15: Virtual master axis - basic functions

Master axis velocity source

The setpoint value is specified by either the parameter "virtual master - speed command 1" (C-0-0006) or by one of the velocities in parameter "virtual master - speed commands" (C-0-0054).

Parameter "ELS master - control word" (C-0-0004) sets whether one speed command (C-0-0006) or eight speed command values (C-0-0054, selected via the I/Os) are used.

Selection in parameter C-0-0004	Inputs for selecting velocity command value _E:L01.09, _E:L01.10, _E:L01.11	Active velocity command value
bit 15 = 0	x	C-0-0006
bit 15 = 1	0 0 0	C-0-0054 Element 1
	1 0 0	C-0-0054 Element 2
	0 1 0	C-0-0054 Element 3
	1 1 0	C-0-0054 Element 4
	0 0 1	C-0-0054 Element 5
	1 0 1	C-0-0054 Element 6
	0 1 1	C-0-0054 Element 7
	1 1 1	C-0-0054 Element 8

Fig. 2-16: Master axis velocity values

The master axis velocity can be altered during operation by

- writing in parameter C-0-0006 or C-0-0054 or
- by using the jog inputs.

Virtual master - speed command presetting

If the input "virtual master - speed command preset" (_E:L01.02) is active when switching the eight speeds, then the newly selected speed is preset with the value preset in "virtual master - speed command pre-setting" (C-0-0053).

Given a positive edge "virtual master - speed command preset" (_E:L01.02), then the currently selected speed is preset with the relevant element from parameter "virtual master - speed command pre-setting" (C-0-0053).

Jogging master axis velocity

Jogging inputs "virtual master jog -" (_E:L01.12) and "virtual master jog +" (_E:L01.13) affect the active speed command value.

A quick signal at one of the jogging input alters velocity by a fixed amount (incremental width). This incremental width, given in rpm/min., can be programmed. If a jogging signal is applied for any length of time, then the velocity is continuously changed by the set incremental width.

Limiting master axis velocity

The parameter "virtual master speed 1 - positive limit" (C-0-0030) and "virtual master speed 1 - negative limit" (C-0-0031) make it possible to set a permissible velocity range. This limit directly effects parameter "virtual master - speed command 1" (C-0-0006).

If eight speed command values are used, then the parameters "virtual master - speed command positive limits" (C-0-0055) and "virtual master - speed command negative limits" (C-0-0056) limit parameter "virtual master - speed commands" (C-0-0054).

Positioning

The positioning mode of the virtual master axis permits a precise deceleration to a stop position and approaching a new position out of standstill.

The binary inputs "VM stop position 1 active" (_E:L01.07) and "VM stop position 2 active" (_E:L01.08) are used for positioning. Each of these inputs has assigned to it one C parameter "virtual master - stop position 1" (C-0-0026) or "virtual master - stop position 2" (C-0-0027). A stop position is activated by setting the corresponding input.

Note: If both inputs "VM stop position 1 active" (_E:L01.07) and "VM stop position 2 active" (_E:L01.08) are set simultaneously, then position 2 takes precedence.

Approaching a stop position

If the "virtual master enable" (_E:L01.06) is applied, then the master axis accelerates to the speed command. If, at this point, an input "virtual master axis - stop position *n* active" is also set, then the selected stop position is approached.

At first, the master axis continues with the current velocity and then brakes with "acceleration bipolar" to the stop position. Once the position has been reached, output "virtual master - in position" (_A:L01.19) is set.

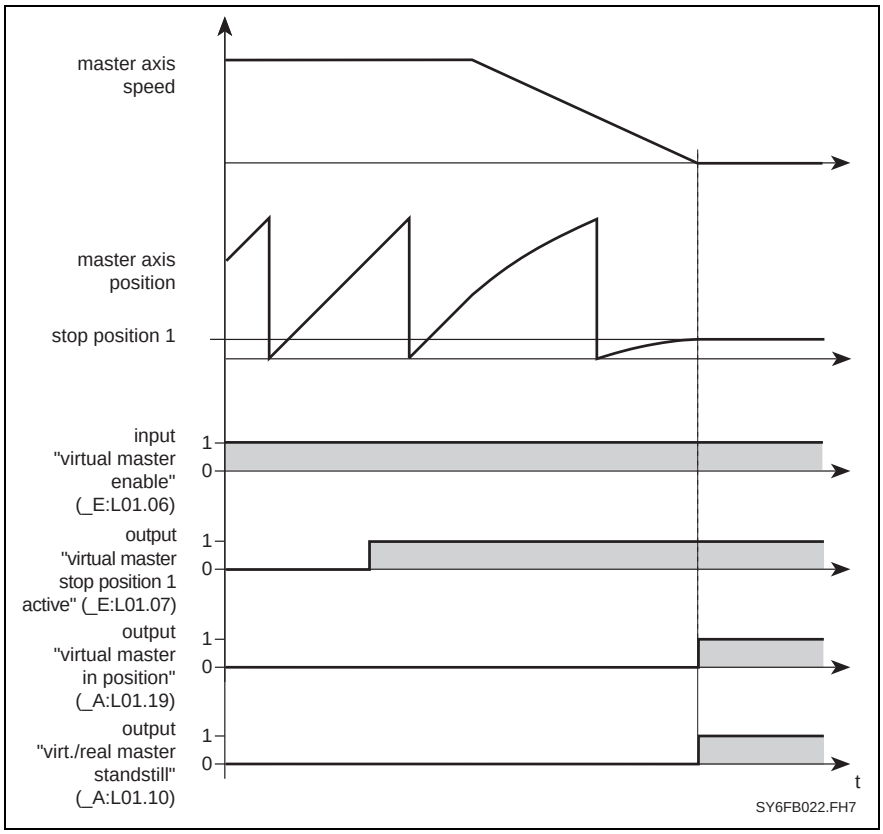


Fig. 2-17: Virtual master axis - approaching a stop position

Starting up out of a stop position

The inputs "virtual master enable" (_E:L01.06) and "VM stop position *n* active" are set and the master axis is standing.

- If a new value is written over the existing activated stop position, then the master axis will move to the new stop position. The positioning direction is set by the polarity of the current speed command value. "Virtual master - bipolar acceleration" (C-0-0008) and "virtual master - bipolar jerk" (C-0-0077) take effect when accelerating to positioning speed and when braking. Positioning speed is limited to the current speed command value.
- If input "virtual master axis - stop position *n* active" is cancelled, then the master axis will accelerate to the current speed command value.

Positioning interrupt

If "virtual master enable" (_E:L01.06) is cancelled during the positioning procedure, then the master axis will brake immediately to standstill with "virtual master - deceleration" (C-0-0009).

If input "virtual master axis - stop position *n* active" is cancelled during positioning, then the master axis will again follow the current speed command value.

Binary I/O of the virtual master axis

The binary inputs of the virtual master axis

Designation	Function
_E:L01.01	Virtual master E-stop
_E:L01.02	VM speed command preset
_E:L01.03	--
_E:L01.04	--
_E:L01.05	Switch to virtual master
_E:L01.06	Virtual master enable
_E:L01.07	VM stop position 1 active
_E:L01.08	VM stop position 2 active
_E:L01.09	VM selection of speed cmd bit 0
_E:L01.10	VM selection of speed cmd bit 1
_E:L01.11	VM selection of speed cmd bit 2
_E:L01.12	Virtual master jog -
_E:L01.13	Virtual master jog +
_E:L01.14	VM jogging speed reduced
_E:L01.15	RM position monitoring enable
_E:L01.16	Real/Virt. master - clear error
...	...
_E:L01.20	VM preset position
_E:L01.25	ELS master command value additive - enable

Fig. 2-18: Binary inputs of the virtual master axis

The binary outputs of the virtual master axis

Designation	Function
_A:L01.01	Virtual master E-Stop
_A:L01.02	RM redundant encoder error
_A:L01.03	Virtual/Real master error
_A:L01.04	--
_A:L01.05	Virtual master axis active
_A:L01.06	VM enable acknowledge
_A:L01.07	VM speed command value achieved
_A:L01.08	Real master moved
_A:L01.09	Real master positive direction
_A:L01.10	Virtual/real master standstill
_A:L01.11	VM speed switching signal 1
_A:L01.12	VM speed switching signal 2
_A:L01.13	VM speed switching signal 3
_A:L01.14	VM speed switching signal 4
_A:L01.15	VM speed switching signal 5
_A:L01.16	VM speed switching signal 6
_A:L01.17	VM speed switching signal 7
_A:L01.18	VM speed switching signal 8

_A:L01.19	Virtual master in position
_A:L01.20	VM preset position acknowledge
_A:L01.21	VM negative jogging limit exceeded
_A:L01.22	VM positive jogging limit exceeded
_A:L01.25	ELS master command value additive achieved

Fig. 2-19: Binary outputs of the virtual master axis

Enable

Once input "virtual master enable" (_E:L01.06) is set, the master axis accelerates with the velocity specified by "virtual master - bipolar acceleration" (C-0-0008) to the velocity set in "virtual master - speed command 1" (C-0-0006) or "virtual master - speed command" (C-0-0054).

Once master axis velocity has reached the command value, then output signal "VM speed command value achieved" (_A:L01.07) is set.

A removal of the enable signal means that braking is initiated with the decel value set in parameter "virtual master - deceleration" (C-0-0009).

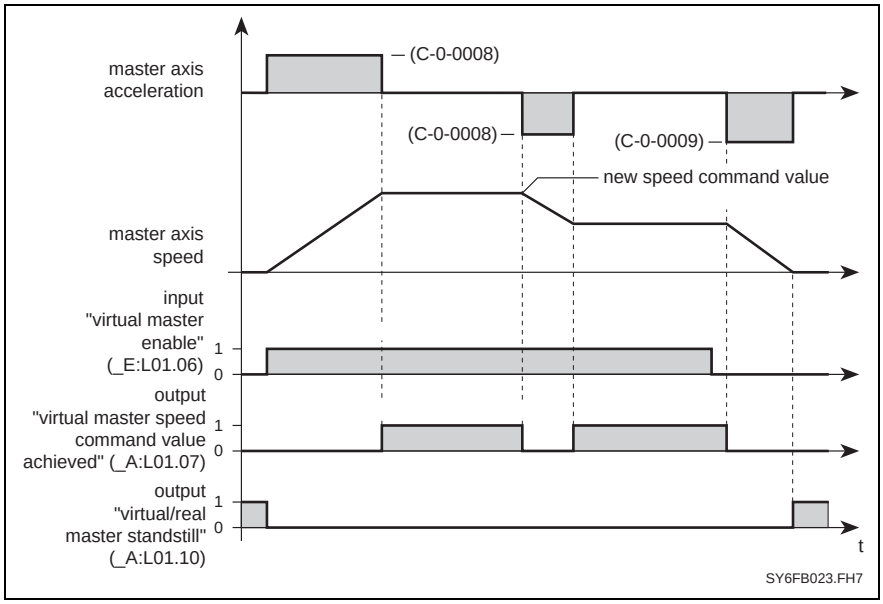


Fig. 2-20: Diagram of a simple switching on and off during idle mode

Standstill signal

The output "Virtual/real master standstill" (_A:L01.10) is set to 1 once the master axis is standing.

E-stop

Input signal "virtual master E-stop" (_E:L01.01) immediately initiates braking to the point of standstill using the deceleration value which has been programmed. The CLC confirms the E-stop with the output signals "virtual/real master E-stop" (_A:L01.01) and "virtual/real master error" (_A:L01.03).

To deactivate the E-stop, it is necessary to

- cancel the E-stop input and
- set the input "virtual/real master - clear error" (_E:L01.16).

The outputs "virtual/real master E-stop" (_A:L01.01) and "virtual/real master error" (_A:L01.03) are then cancelled.

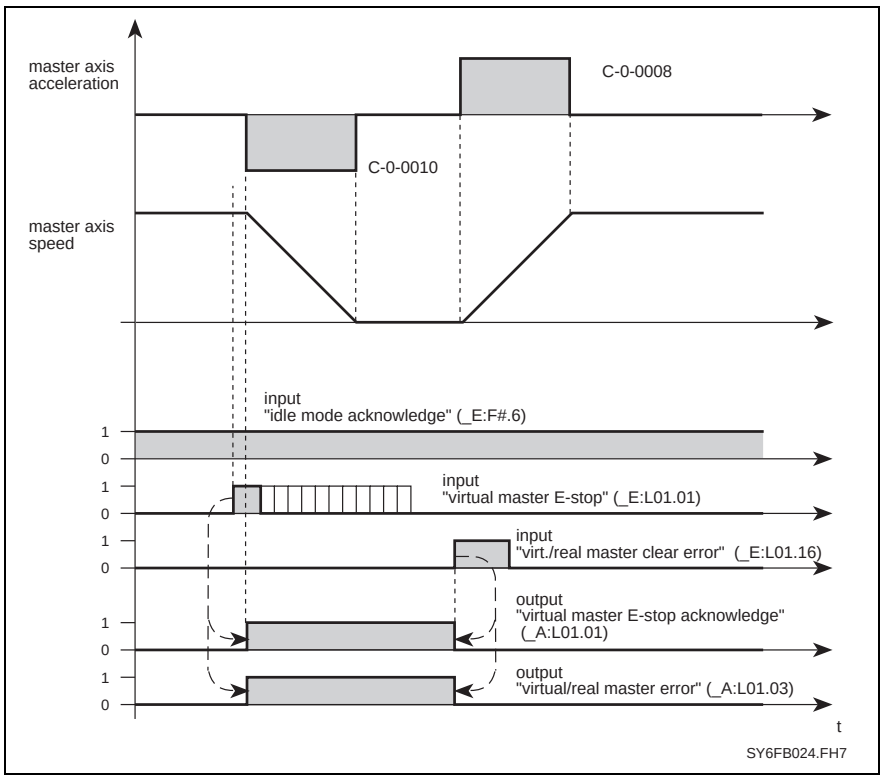


Fig. 2-21: E-stop function of the virtual master axis

The emergency stop is not generally equipped with jerk limit. If deceleration with jerk-limit is needed, then it can be activated in "ELS master - control word" (C-0-0004):

Parameter C-0-0004	**Emergency stop with jerk limit**
Bit 8 = 0	not active
Bit 8 = 1	active

Fig. 2-22: Emergency stop with jerk limit

If the jerk limit is active, then parameter "virtual master - bipolar jerk" (C-0-0077) is also effective.

Parameters for operating the virtual master axis

The following is a list of all relevant CLC system parameters required to operate the virtual master axis.

(For details see "SYNAX Parameter Description", DOK-SYNAX*-SY*-06VRS**-PA01-EN-P.)

Parameter number	Designation
C-0-0004	ELS master - control word
C-0-0006	Virtual master - speed command 1
C-0-0008	Virtual master - bipolar acceleration
C-0-0009	Virtual master - deceleration
C-0-0010	Virtual master - emergency stop deceleration
C-0-0026	Virtual master - stop position 1
C-0-0027	Virtual master - stop position 2
C-0-0028	Virtual master - speed increment
C-0-0030	Virtual master speed 1 - positive limit
C-0-0031	Virtual master speed 1 - negative limit
C-0-0045	Reserved (virtual master - position increment)
C-0-0052	ELS master - speed operating points
C-0-0053	Virtual master - speed command presetting
C-0-0054	Virtual master - speed commands
C-0-0055	Virtual master - speed command positive limits
C-0-0056	Virtual master - speed command negative limits
C-0-0066	ELS master - actual position value
C-0-0067	ELS master - actual speed value
C-0-0075	Virtual master - preset position
C-0-0077	Virtual master - bipolar jerk
C-0-0149	ELS master command value additive
C-0-0150	ELS master command value additive
C-0-0160	ELS master - actual additive position value
C-0-0161	ELS master command value additive - positive limit
C-0-0162	ELS master command value additive - negative limit
A-0-0159	ELS master command value additive selection
P-0-0053	Lead drive position
P-0-0059	SSI-emulator-resolution
P-0-0108	Lead drive polarity

Fig. 2-23: Parameters for operating the virtual master axis

2.4 Additive master axis command value

A "ELS master - command value additive" (C-0-0149) can be added to the position of a virtual or a real master axis. This can be used to offset the master axis over the entire SYNAX ring or any selected following axis. Each slave axis can be programmed as to whether the additive component effects a drive or not with parameter "ELS master - command value additive selection" (A-0-0159):

- A-0-0159 = 0: master axis command value additive not effective
- A-0-0159 > 0: master axis command value additive effective

  In applications with one CLC control, any value ranging from 1 to 32 can be set in A-0-0159.

  In the CLC link of several CLC controls, " ELS master - command value additive " (C-0-0149) can work beyond the CLC (see section 13.10 "Additive master axis command value in the CLC link"). The address of the CLC which distributes the additive command value within the CLC link must then be entered in parameter A-0-0159.

A change of the additive position command value is performed with the "ELS master - command value offset speed" (C-0-0150). Once the parametrized value is reached, then binary output "position command value additive achieved" (_A:L01.25) is set.

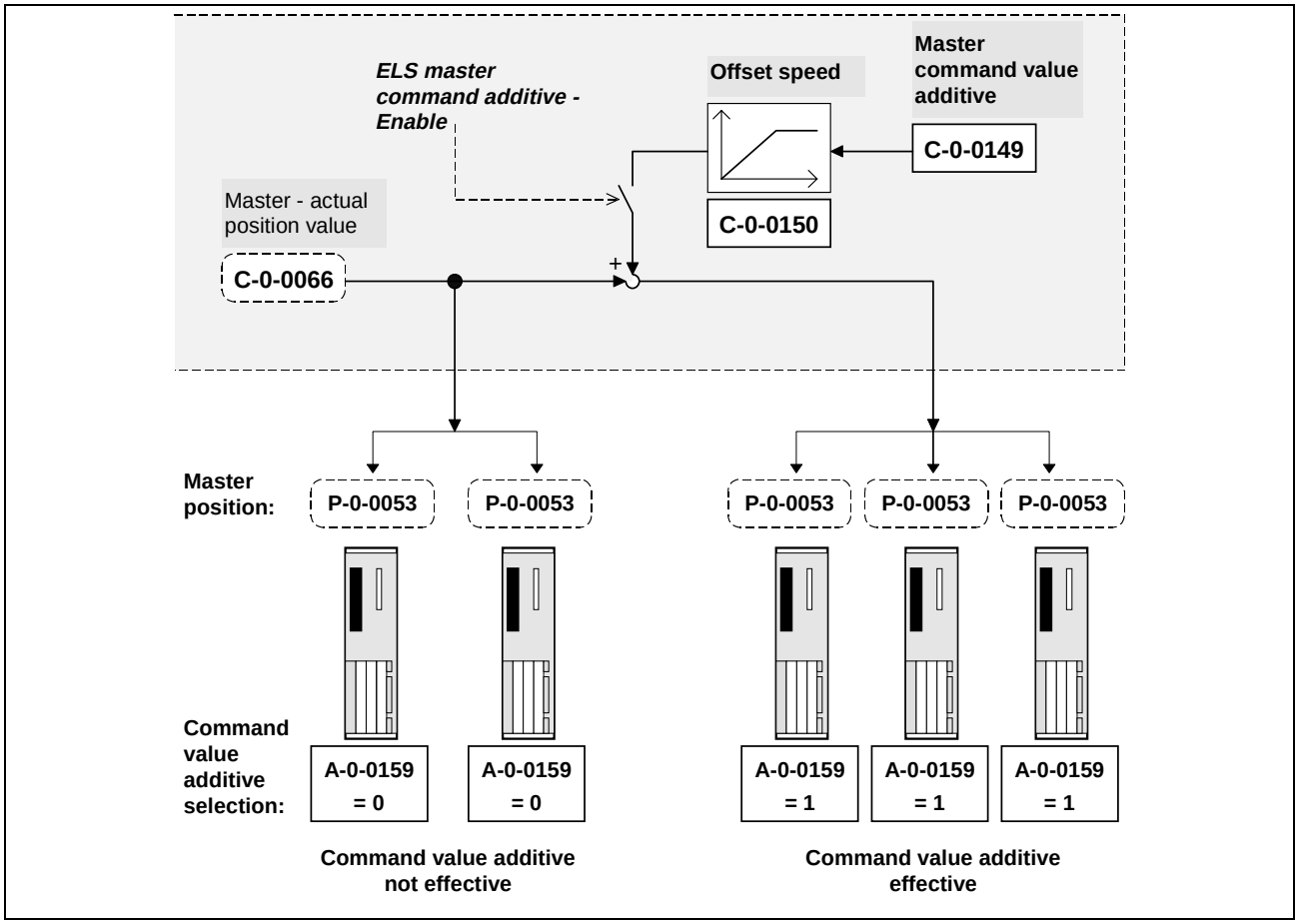


Fig. 2-24: The effects of the "master axis position command value additive"

The "ELS master - command value additive" must be enabled using a binary input. The additive command value is taken into account only if input "ELS master command value additive - enable" (_E:L01.25) is set.

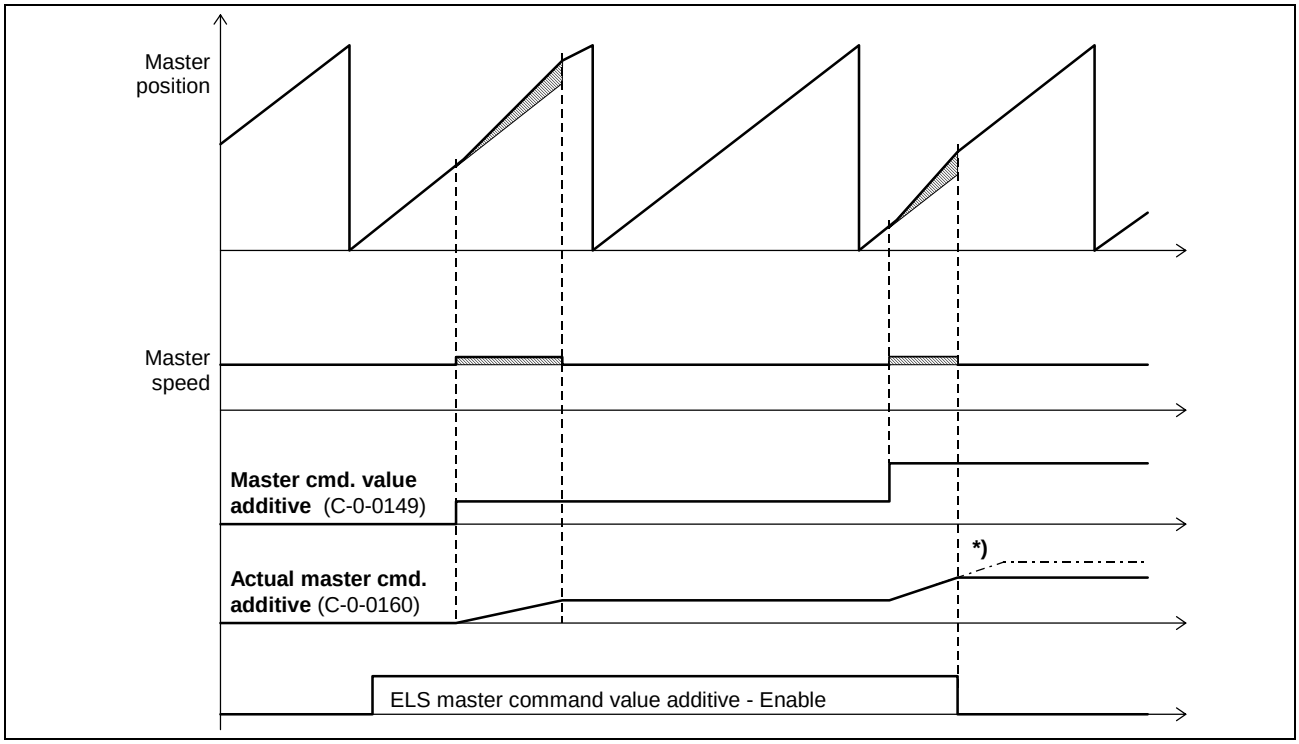


Fig. 2-25: ELS master command value additive - Enable

* If the enable signal is reset during an offset adjustment, the additive component is no longer added to the master position. A remainining command difference is buffered and is taken into account with the next raising edge at the enable input.

Note: Neither a jerk nor an acceleration limit for the offset results so that only very slow offset speeds make sense.

2.5 Standard cam switches

Depending upon the angle position of the master axis, the standard cam switches can be used to switch signals on and off. The ON actuating and OFF actuating angles can be programmed. Six cams are available for this purpose.

The standard cam switches can be used with either the real or the virtual master axis.

The standard cam swtiches are always active. No external signal is needed to switch this function on.

Standard cam switches are suitable for simple applications only.

Example: Aligning a master axis encoder.

Binary I/Os of the standard cam switches

Each cam has an output "virtual/real master cam switch bit *n*" assigned to it. Output *n* is set if the master axis position exceeds the value "cam switch bit n actuating angle".

An example for three cams is listed below:

Standard cam switch bit 1 ON angle = 90°
Standard cam switch bit 1 OFF angle = 225°
Standard cam switch bit 2 ON angle = 330°
Standard cam switch bit 2 OFF angle = 20°
Standard cam switch bit 3 ON angle = 200°
Standard cam switch bit 3 OFF angle = 240

The following outputs are available on the CLC for the cam switches:

Designation	Function
_A:N01.01	Standard cam switch bit 1
_A:N01.02	Standard cam switch bit 2
_A:N01.03	Standard cam switch bit 3
_A:N01.04	Standard cam switch bit 4
_A:N01.05	Standard cam switch bit 5
_A:N01.06	Standard cam switch bit 6

Fig. 2-26: Standard cam switch outputs

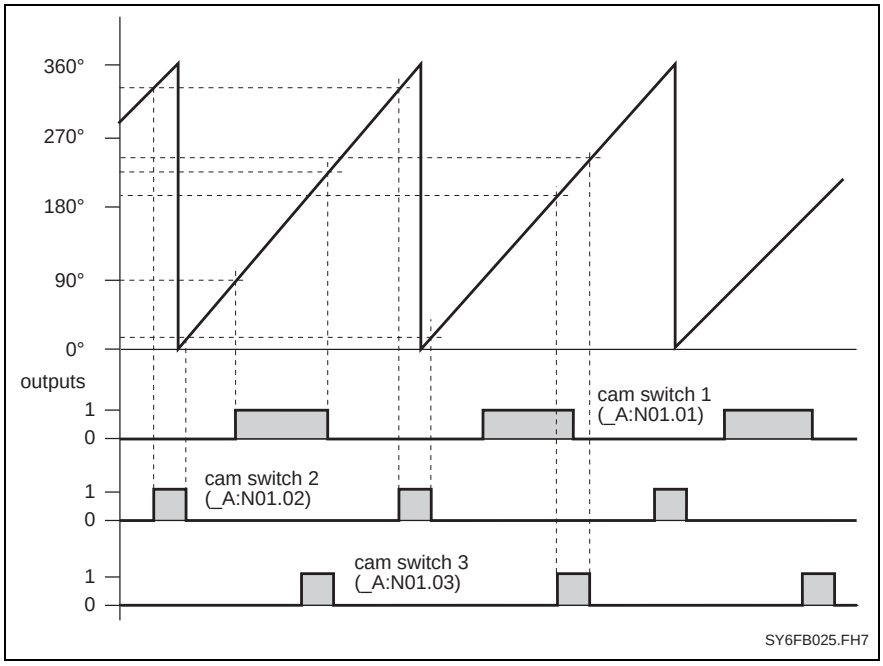


Fig. 2-27: Standard cam switch with three cams

Parameters of the standard cam switch

The following is a list of all relevant CLC system parameters for the standard cam switches.

(For details see "SYNAX Parameter Description", DOK-SYNAX*-SY*-06VRS**-PA01-EN-P.)

Parameter number	Designation
C-0-0016	Cam switch group 1 - switch 1 ON angle
C-0-0017	Cam switch group 1 - switch 1 OFF angle
C-0-0018	Cam switch group 1 - switch 2 ON angle
C-0-0019	Cam switch group 1 - switch 2 OFF angle
C-0-0020	Cam switch group 1 - switch 3 ON angle
C-0-0021	Cam switch group 1 - switch 3 OFF angle
C-0-0022	Cam switch group 1 - switch 4 ON angle
C-0-0023	Cam switch group 1 - switch 4 OFF angle
C-0-0034	Cam switch group 1 - switch 5 ON angle
C-0-0035	Cam switch group 1 - switch 5 OFF angle
C-0-0036	Cam switch group 1 - switch 6 ON angle
C-0-0037	Cam switch group 1 - switch 6 OFF angle

Fig. 2-28: Parameter for standard cam switch

2.6 High speed standard cam switch

Functional Principle

Depending on the position of the angle of the master axis, the high-speed cam switch can be used to set binary outputs. The cams can be output on an I/O card in the drive, an I/O card in a CCD box or on the dual port RAM of a CLC-P. Up to 32 high-speed cams can be parametrized depending on the output unit.

The high speed cam switches can be used with either the real or the virtual master axis.

An output *n* is set if the master axis position lies between "high speed cam switch *n* - on angle" and "high speed camswitch *n* - off angle".

Example

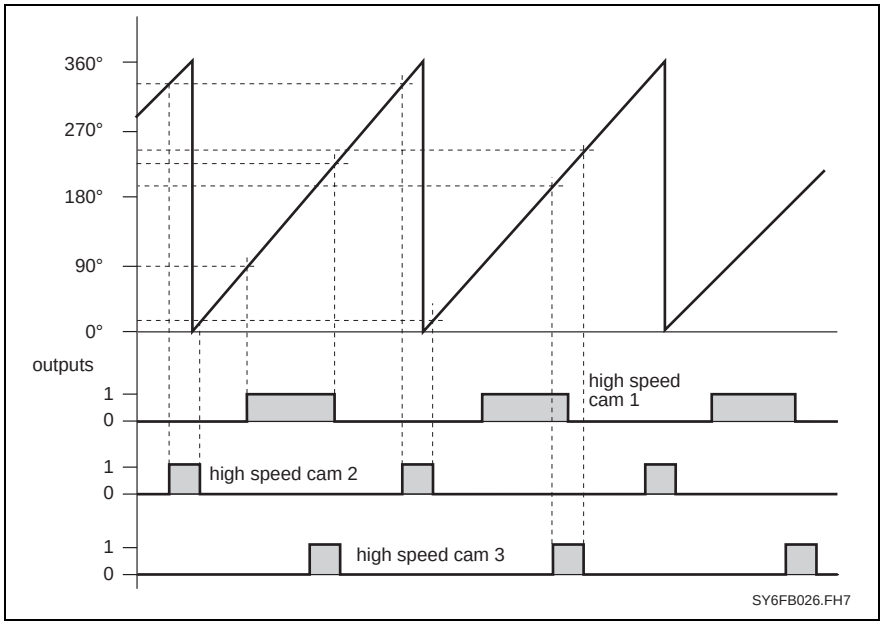


Fig. 2-29: High speed cam switch with three cams

High speed cam switch 1 - ON angle = 90°
High speed cam switch 1 - OFF angle = 225°
High speed cam switch 2 - ON angle = 330°
High speed cam switch 2 - OFF angle = 20°
High speed cam switch 3 - ON angle = 200°
High speed cam switch 3 - OFF angle = 240°

Configuration

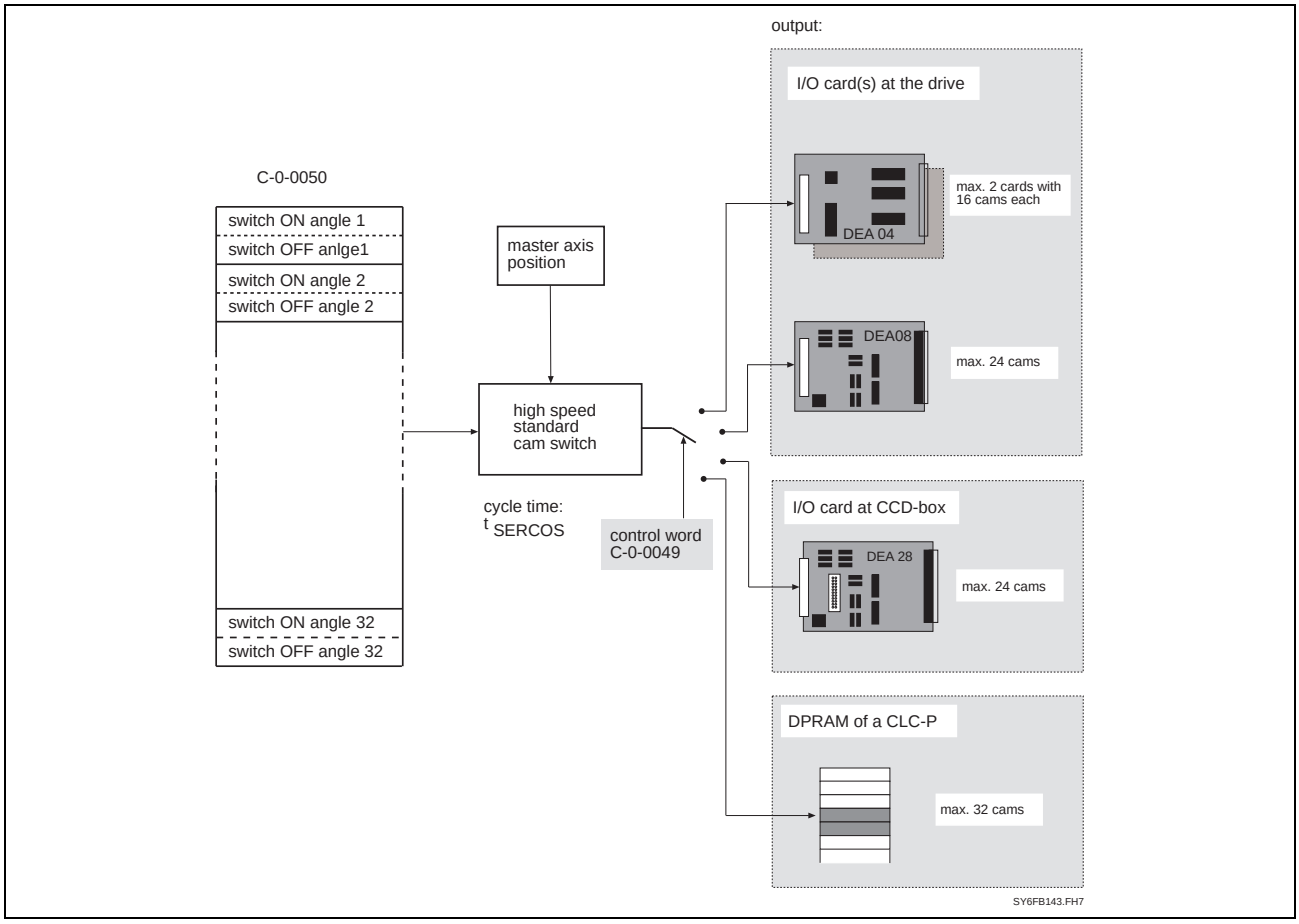


Fig. 2-30: : High-speed cam output

The output unit and the number of high-speed cams are configured in "high speed cam switches - control word" (C-0-0049):

C-0-0049 Bit 1- 0	**Number of high speed cams**
0 0	High speed cam switches not active
0 1	16 at DEA04
1 0	24 at DEA08 and DEA28 32 at DEA04 and DPRAM

Fig. 2-31: Number of high speed cams

C-0-0049 Bit 9 - 8	Cam output on ...
0 0	1...2 I/O cards - type DEA04
0 1	dual port RAM of an CLC-P
1 0	1 I/O card - type DEA28
1 1	1 I/O card - type DEA08
0 0	High-speed cams can be used in the I/O logic if all A-0-0036 = 0

Fig. 2-32: Selecting the output unit

If cams are output via input modules in the drive (DEA04, DEA08), then the I/O card must be configured in parameter "digital I/O status" (A-0-0036) for the relevant drive.

A-0-0036	Configuration
bit 1 = 0	no DEA for high speed cam
bit 1 = 1	I/O card for high speed cam inserted

Fig. 2-33: Settings in parameter A-0-0036

Output via DEA04

Up to 16 cams can be output on a maximum of two I/O cards, type DEA04. The I/O cards are inserted into any two drive controllers.

The cams are allocated to the DEA cards in such a way that cams 1 through 16 are assigned to the cards with the low drive addresses, while the cards with the higher addresses are used for cams 17 to 32. The cams are counted according to the sequence of the ON and OFF actuating angles in the "high speed cam switches - ON/OFF angle" (C-0-0050).

DEA04 pin assignment:

Cams 1 ... 16		Cams 17 ... 32	
Pin	**reserved for**	**Pin**	**reserved for**
1		1	
..	Binary inputs	..	Binary inputs
..	for the I/O logic	..	for the I/O logic
15		15	
16	High Speed Cam 1	16	High Speed Cam 17
17	High Speed Cam 2	17	High Speed Cam 18
18	High Speed Cam 3	18	High Speed Cam 19
..	.....	..	.....
..	.....	..	.....
31	High Speed Cam 16	31	High Speed Cam 32
35	external power supply, ground	35	external power supply, ground
37	external power supply, 24 V	37	external power supply, 24 V

Fig. 2-34: DEA04 assignment with the use of high-speed cams

Output via DEA08

Up to 24 cams can be output on one I/O card, type DEA08. The DEA08 is inserted into any drive controller.

DEA08 pin assignment:

Pin	Assignment
1 ... 11	binary inputs of the I/O logic
22 ... 32	- " -
43 ... 52	- " -
12 ... 19	high-speed cam 1 ... 8
33 ... 40	high-speed cam 9 ... 16
53 ... 60	high-speed cam 17 ... 24
21, 42, 62	external supply, ground
41, 61	external supply, 24 V

Fig. 2-35: DEA08 assignment with the use of high-speed cams

Output via DEA28

Up to 24 cams can be output on one I/O card, type DEA28. The DEA28 is available as a plug-in card for the CLC-D in a CCD box.

Pin assignment for DEA28: same as DEA08.

Output via dual port RAM

Up to 32 cams can be output in the DPRAM of a CLC-P. The cams are written behind the feedback values of the master axis into the 'real-time data feedback value buffer' (address offset 0x0808).

Note: I/O card outputs not used may not be used as binary output signals for the I/O logic.

Parameters for high speed cam switches

The following lists all CLC parameters for the high speed cam switches.

Parameter number	Designation
C-0-0049	High speed cam switches - control word
C-0-0050	High speed cam switches - ON/ OFF angle
C-0-0130	Internal I/O: high speed cam switches outputs (for diagnostics)
A-0-0036	Digital I/O - configuration

Fig. 2-36: Parameter for high speed cam switch

2.7 Speed operating points

With the speed switching signals functions specific to the applications can be activated according to the speed of the master axis. Binary outputs are set or reset when speeds exceed programmable values. Speed operating points are programmed in rpm. One binary output is assigned to every two operating points. Eight outputs are available.

Speed switching signals are always output in terms of the effective master axis speed.

Binary I/O

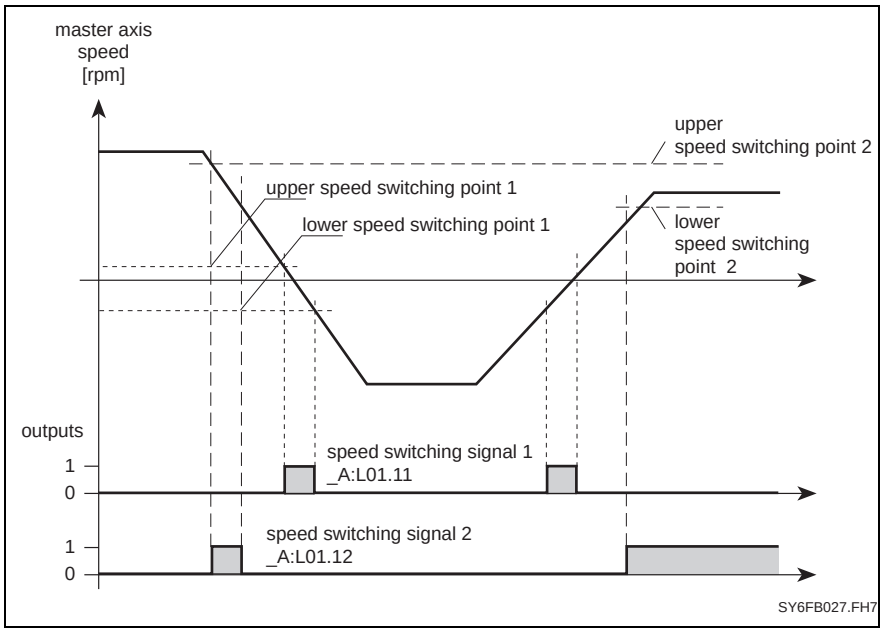


Fig. 2-37: Virtual master axis with two speed switching points

Internal outputs

Output	Function
A:L01.11	VM speed switching signal 1
A:L01.12	VM speed switching signal 2
A:L01.13	VM speed switching signal 3
A:L01.14	VM speed switching signal 4
A:L01.15	VM speed switching signal 5
A:L01.16	VM speed switching signal 6
A:L01.17	VM speed switching signal 7
A:L01.18	VM speed switching signal 8

Fig. 2-38: Internal outputs

Parameters for the speed switching point

The following is a list of all CLC system parameters relevant to the speed switch group.

Parameter number	Designation
C-0-0052	ELS master - speed operating points

Fig. 2-39: Parameter for the speed switching signals

2.8 Master toggle mode between real and virtual master axes

Function description

The master toggle mode makes it possible to changeover from real to virtual master axis during operation. This means that all drives are switched which are assigned as following axes to the master axis of a SYNAX ring.

The master toggle mode between real and virtual master axis is set in parameter "ELS master - control word" (C-0-0004) using one of the following bit combinations:

Parameter C-0-0004	Command value source (see "Basic function", page 2-13)
00000000 00x10001	C-0-0006
10000000 00x10001	C-0-0054

Fig. 2-40: Bit combination for master toggle mode

For the master toggle mode, the real master function **must** be preset (see table above, bit 0 in "ELS master - control word").

The changeover between real and virtual master axis takes place via the binary input "switch to virtual master" (_E:L01.05). The output "virtual master axis active" (_A:L01.05) specifies which master axis has the lead.

It applies:

Output "Switch to virtual master"	
positive edge	change to virtual master axis
negative edge	change to real master axis
Output "virtual master axis active"	
0	real master axis active
1	virtual master axis active

Fig. 2-41: Definition of the I/Os

The state of the system is buffered on the CLC. This guarantees that the previously valid state is displayed with output "virtual master axis active" (_A:L01.05) upon powering up.

Change from real to virtual master axis

The change from real to virtual master axis is triggered by a positive edge at input "switch to virtual master" (_E:L01.05). The virtual master axis restarts with the current values of position and speed of the real master axis. It then becomes the master axis for the following axes.

The behavior of the virtual master axis after the changeover depends on the state of the binary inputs at the time of the changeover and on the command value source which has been set. Inputs "virtual master enable" (_E:L01.06), "virtual master stop position 1 active" (_E:L01.07) and "virtual master stop positon 2 active" (_E:L01.08) determine whether the master axis stops immediately, travels to a stop position or follows the current speed command value. The command value source (C-0-0006 or C-0-0054) determines the speed of the virtual master axis after the changeover.

The effects of binary inputs "virtual master enable" (_E:L01.06) and "VM stop position *n* active":

En-able	**Stop active**	**Behavior of the virtual master axis after switching**
0	x	**Behavior** The master axis brakes with "virtual master - deceleration" (C-0-0009) to standstill.
1	0	**Continue at constant velocity** The virtual master axis restarts with the actual velocity of the real master axis and then follows the current velocity command value.
1	1	**Positioning** The virtual master axis restarts with the actual velocity of the real master axis and the proceeds to the selected **stop position.**

Fig. 2-42: The effects of "virtual master enable" (_E:L01.06) and "VM stop position *n* active":

Effective velocity command value:

Command value source (bit 15, C-0-0004)	**Velocity select (binary inputs)**	**Velocity command value of the virtual master axis after changeover**
C-0-0006	x x x	preset velocity (C-0-0006) effective
C-0-0054	bit 2 1 0 0 0 1 0 1 0 0 1 1 1 0 0 1 0 1 1 1 0 1 1 1	preset velocity (element of the command value list selected C-0-0054) effective
C-0-0054	bit 2 1 0 0 0 0	the speed of the real master axis at the time of changeover is copied into the first element of the command value list C-0-0054 and is effective as the command value.

Fig. 2-43: Effective velocity command value

Approaching a stop position

If the virtual master axis is to travel to a stop position after the changeover, then the input "virtual master enable" (_E:L01.06) and one of the inputs "VM stop position n active" must be set at the time of the changeover (positive edge at input "switch to virtual master", _E:L01.05).

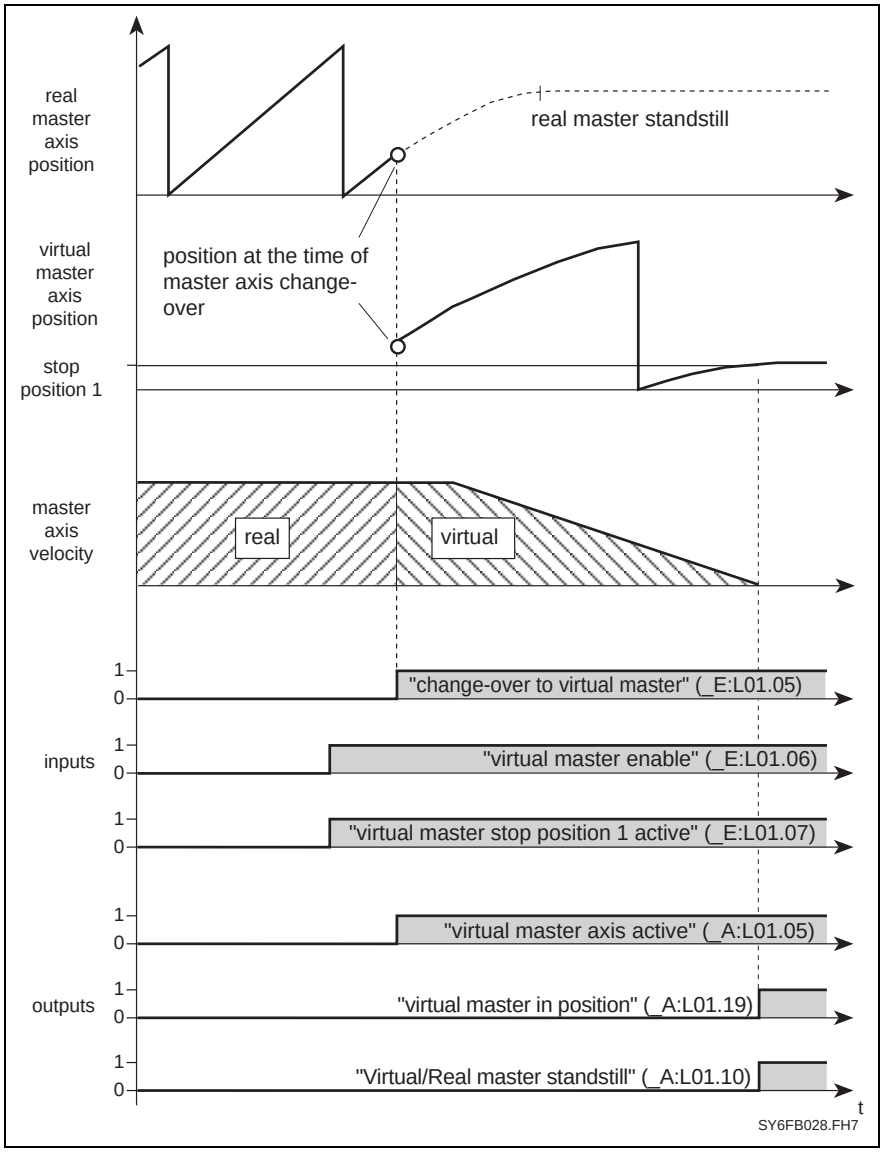


Fig. 2-44: Changeover of real to virtual master axis with active stop position 1

Travel with preset velocity

If input "virtual master enable" (_E:L01.06) is set at changeover and no stop position is active, then the master axis will follow the current velocity command value. Depending upon what has been set in "ELS master - control word" (C-0-0004), the command value is taken either from parameter "virtual master - speed command 1" (C-0-0006) or "virtual master - speed commands" (C-0-0054). After changeover, the virtual master axis either accelerates or decelerates to the current command value.

If command value list C-0-0054 has been set as the command value source, in order to be able to assume a preset command value it is necessary to select a list element other than element '0'. The selection is made via the three binary inputs "VM selection of speed cmd bit n" (see "Basic function", page 2-13).

The bit combination '000' triggers the special function described in the following section.

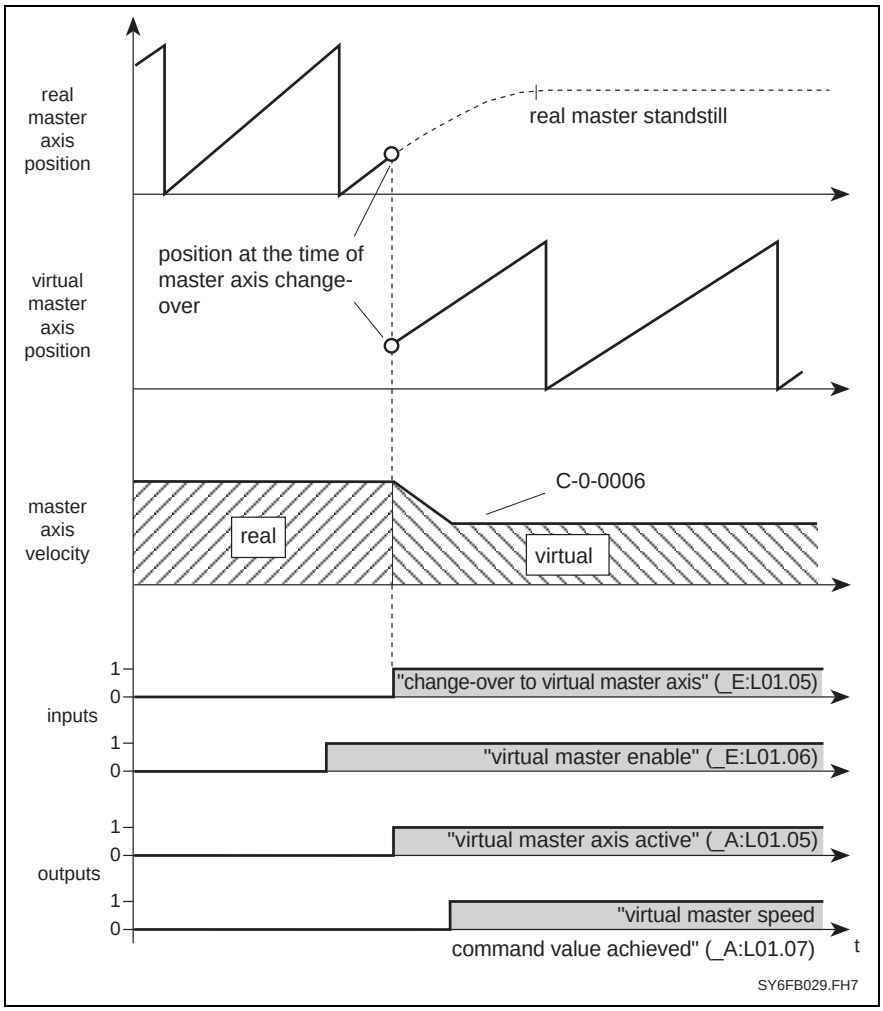


Fig. 2-45: Changeover from real to virtual master axis with constant velocity (C-0-0006)

Changeover with "real" velocity

If command value list C-0-0054 is set as command value source and the first element of the command list has been selected (bit combination '000') via the three binary inputs "VM selection of speed cmd bit *n*", then the current velocity command value of the real master axis is taken over at the time of switching into the first report group elementary item.

The limit values (C-0-0055 and C-0-0056) apply to the command value list C-0-0054 when the velocity command value is assumed. If the velocity of the real master axes should exceed the prorammed limits, then the respective limit value will be written into the first report group elementary item of the current actual value and be effective as the new command value.

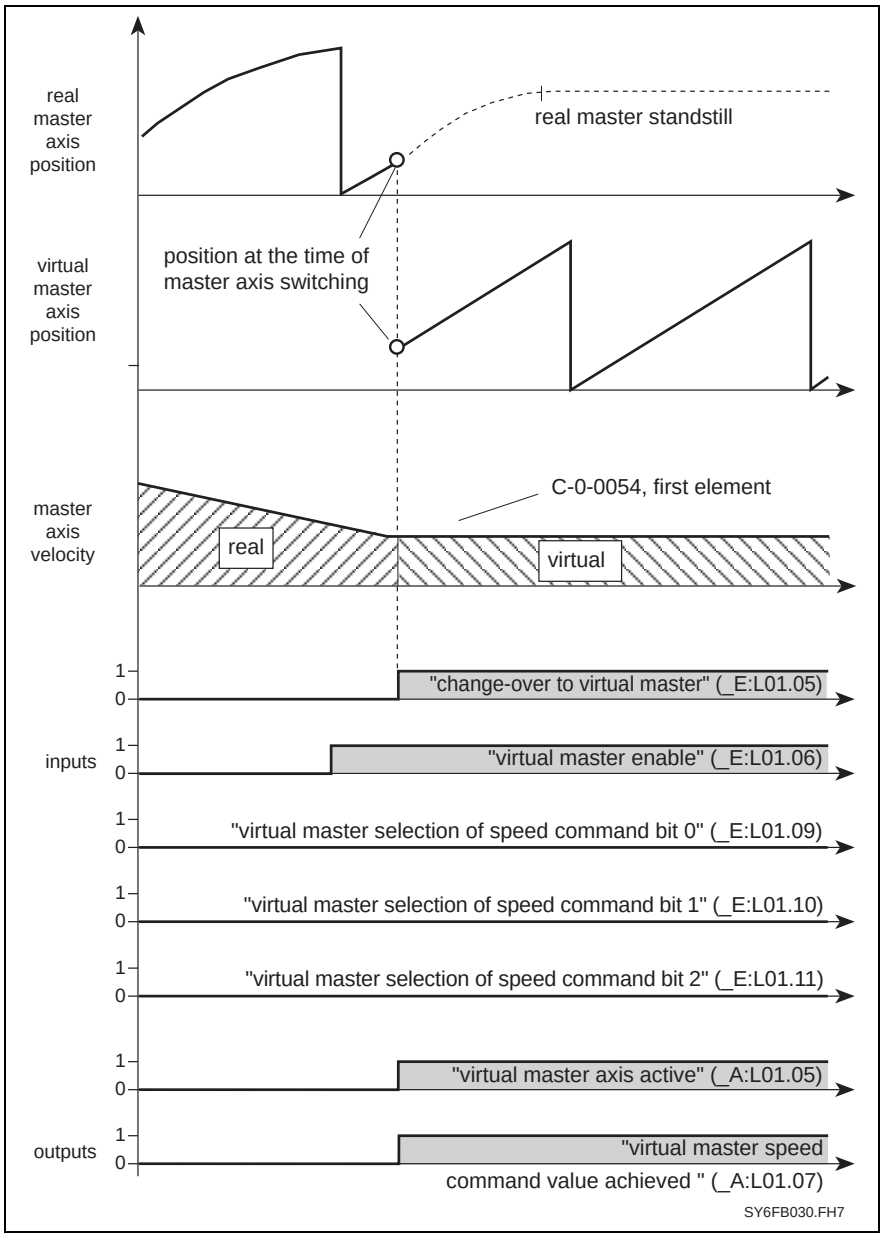

real master axis position
real master standstill
position at the time of master axis switching
virtual master axis position
C-0-0054, first element
master axis velocity
real
virtual
1
0
"change-over to virtual master" (_E:L01.05)
inputs
"virtual master enable" (_E:L01.06)
"virtual master selection of speed command bit 0" (_E:L01.09)
"virtual master selection of speed command bit 1" (_E:L01.10)
"virtual master selection of speed command bit 2" (_E:L01.11)
"virtual master axis active" (_A:L01.05)
outputs
"virtual master speed command value achieved " (_A:L01.07)
SY6FB030.FH7

Fig. 2-46: Change to virtual master axis with assumption of real velocity (C-0-0054)

Changeover from virtual to real master axis

The changeover from virtual to real master axis is triggered by a negative edge at input "switch to virtual master" (_E:L01.05). The real master axis guides the following axis once the virtual master is standing and the real master has passed the virtual master.

If the actual position value of the real master axis is different from that of the virtual master axis position at the time of changeover, then no command values are transmitted to the following axis for the time being. This represents an abrupt change in the command value. Command value transmission is activated when the real master axis achieves the actual position of the virtual master axis.

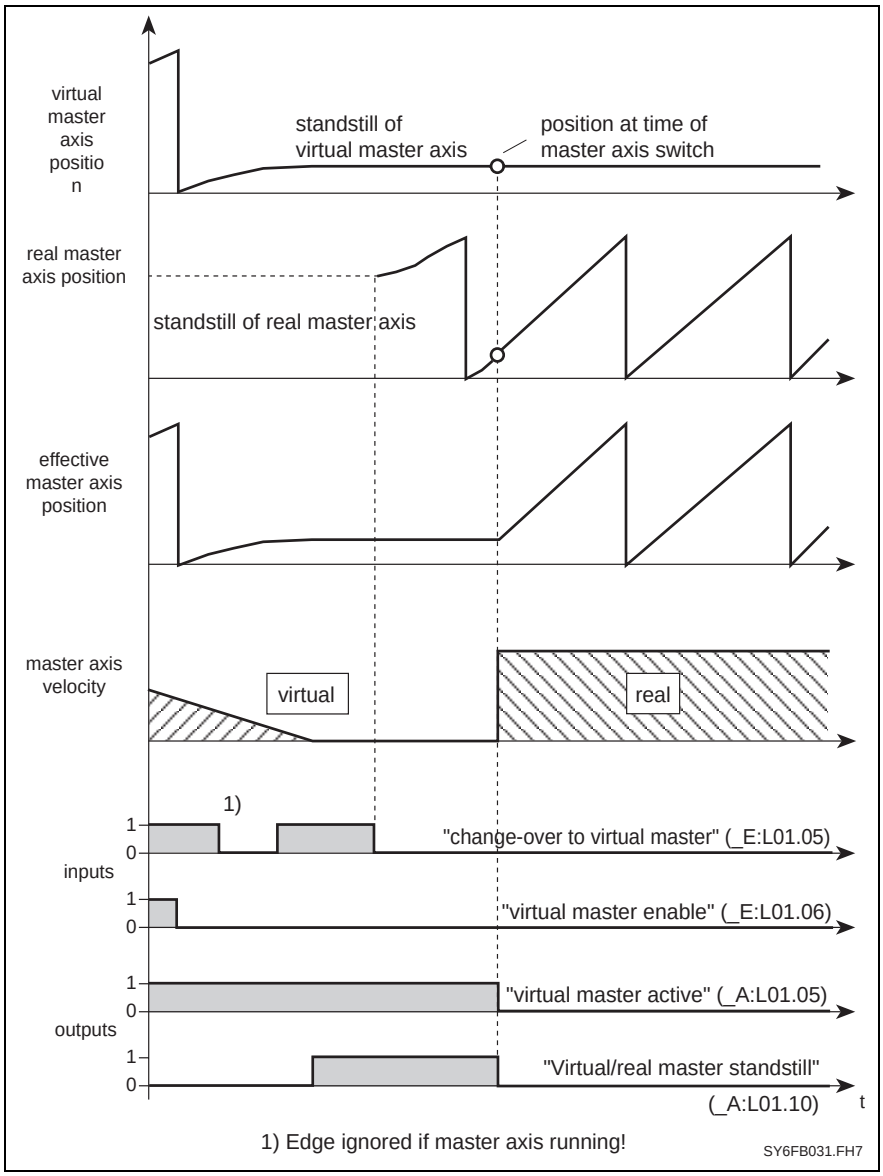


Fig. 2-47: Changeover from virtual to real master axis

Note: The changeover to real master axis is only performed when the virtual master axis is at standstill.

3 Following axis

3.1 Following axes operating modes

A distinction is made between synchronization mode and various auxiliary modes.

In synchronisation mode, the following axis is always moving synchronously to the master axis.

In auxiliary modes the following axis can be moved independently of the master axis.

Operating modes	Function
synchronization	Synchronity with the leading axis; the following and master axes are firmly coupled.
setup	Moving into specific angular positions without synchronization with the master axis.
idle	Moving at constant speed without synchronization with the master axis.
user-defined auxiliary mode	Free selectable special mode

Fig. 3-1: Following axis operating modes

3.2 Synchronization

It is possible for digital intelligent Indramat drives to synchronize up to forty following axes with one master axis using the "electronic shaft" system.

Below is a schematic diagram of a following axis in synchronization:

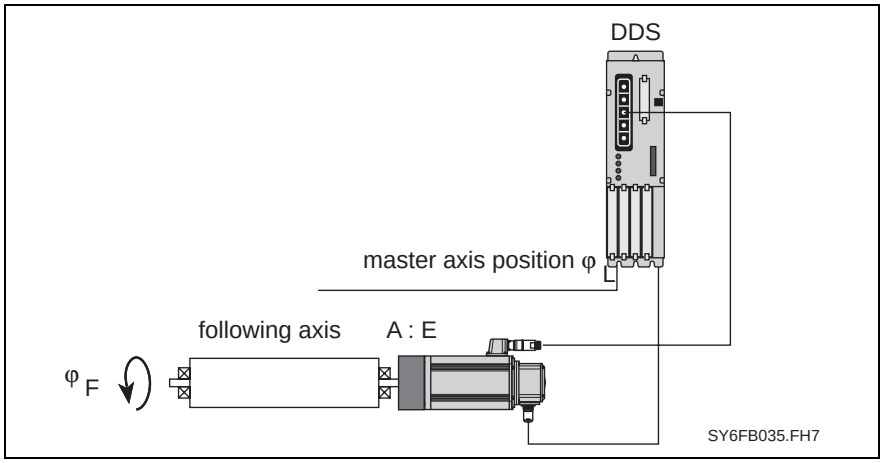


Fig. 3-2: Synchronizing a following axis

Using master axis position φ_L the set point position φ_F of the following axis is calculated in the drive.

A load gearbox on the motor of the following axis is taken into account in this calculation. This means that all parameters, e.g., actual position, speed and so on, relate to the gearbox output.

The following synchronization modes are supported:

- speed synchronization
- phase synchronization
- electronic cam
- electronic pattern control

The synchronization can be separately set for each slave drive in parameter "synchronization mode" (A-0-0003).

In "synchronization" mode, the relationship between slave and master axis is set in the drive via the gear functions. Depending on the selected synchronization mode, various gear functions are active.

Gear functions

The mechanical coupling unit between motor and load as well as the gear ratio between slave and master axis are set via parameters in the drive. In the various synchronization operating modes, the following gear modes are active:

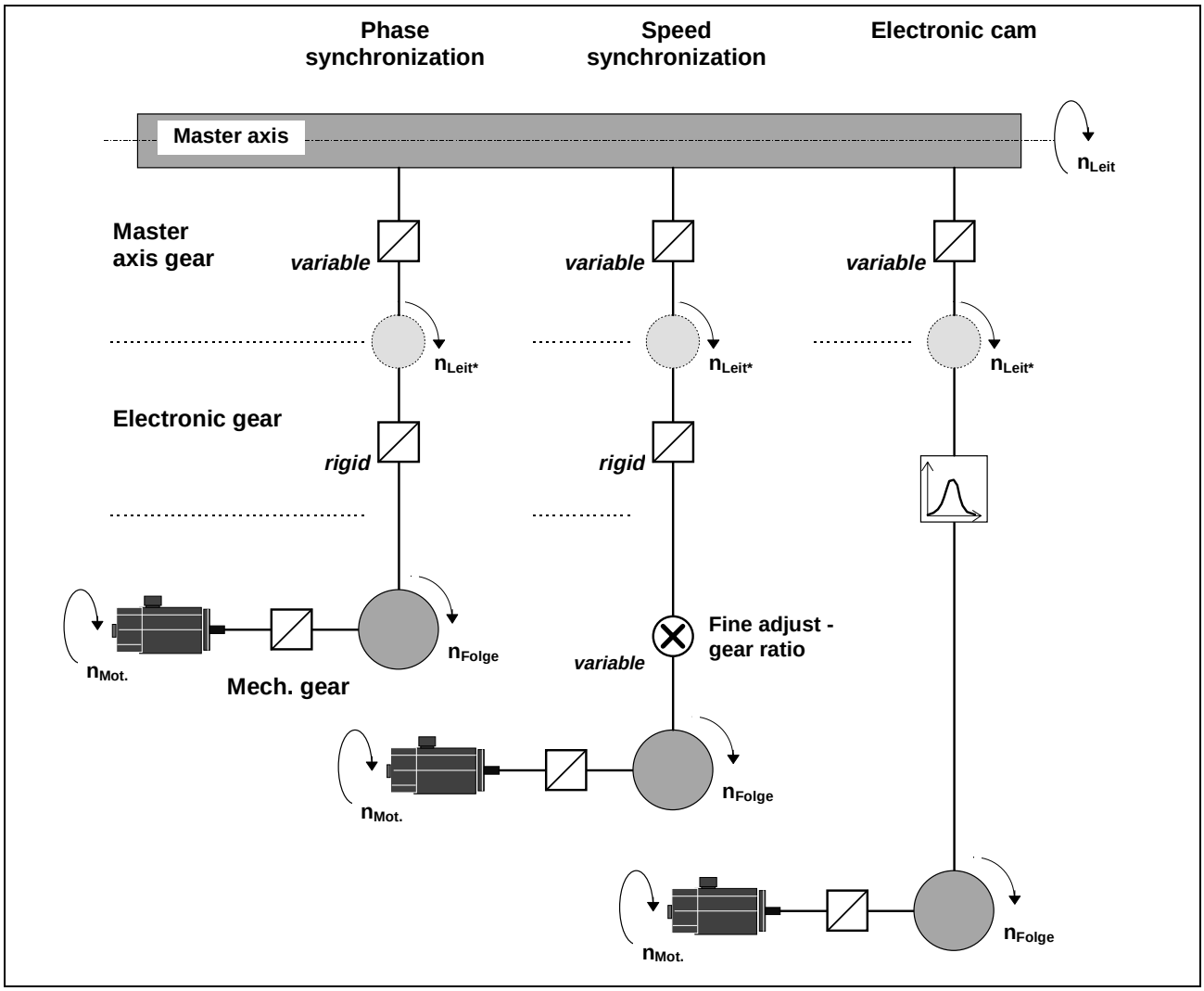


Fig. 3-3: Gear functions

The mechanical gear

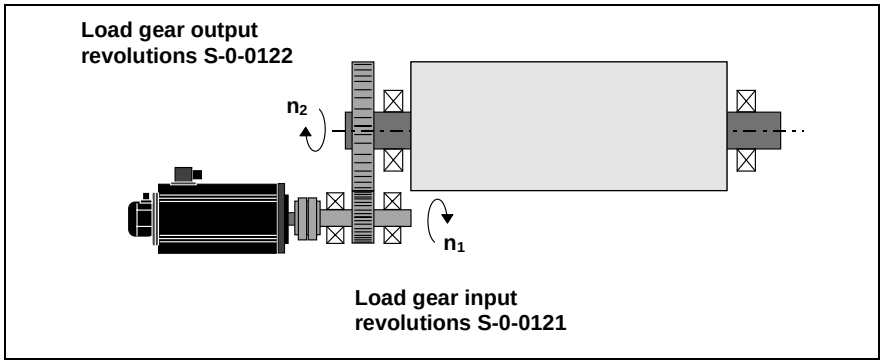


Fig. 3-4: Mechanical gear

All drive-internal position, speed and acceleration data are illustrated in terms of the load. To compute these variables in terms of the load it is necessary to input the mechanical ratio into parameters S-0-0121 and S-0-0122.

The electronic gear

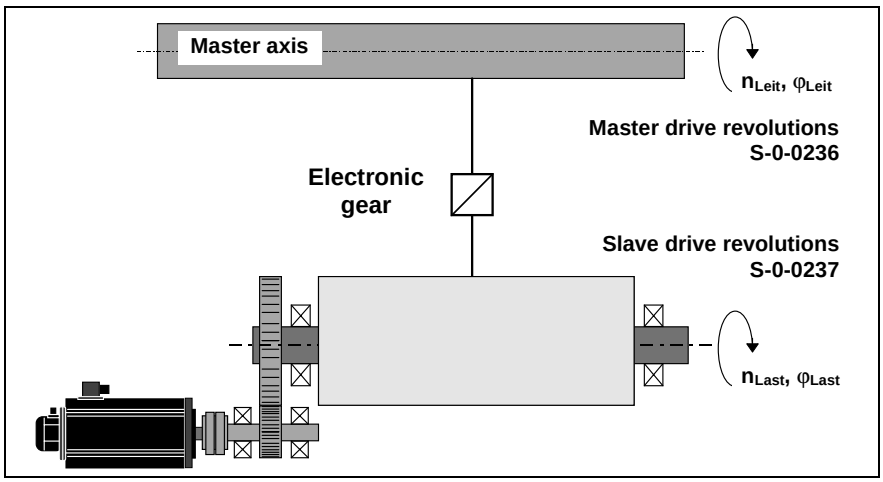


Fig. 3-5: Electronic gear

Using the electronic gear, a basic ratio between slave and master axis can be set.

The number of revolutions must be entered as a whole number.

The electronic gear ratio is set in parametrization mode and cannot be altered when in operating mode.

The master axis gear

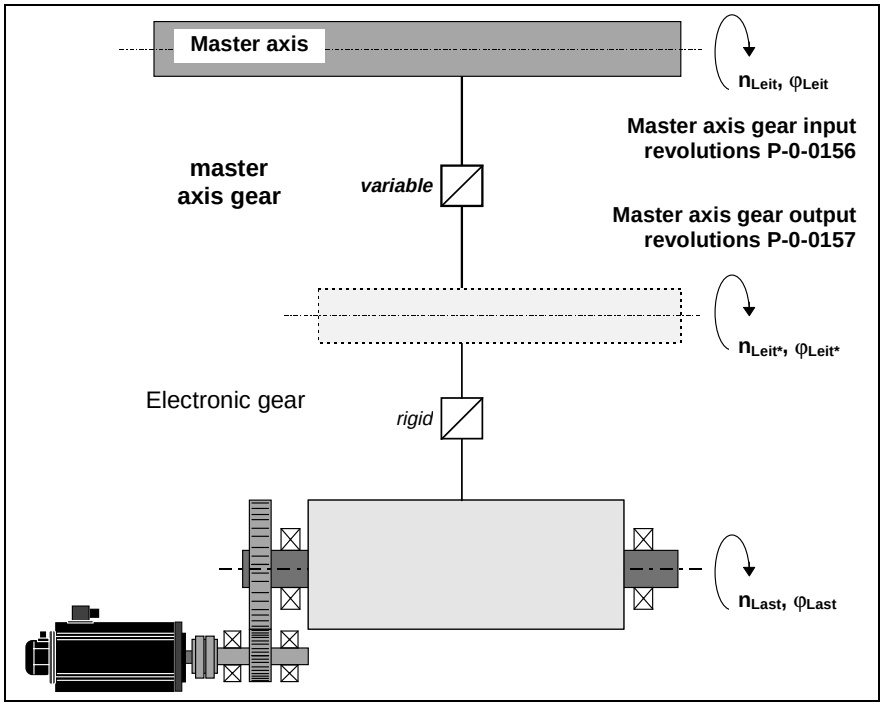


Fig. 3-6: Master axis gear

The master axis gear is switched between master axis and electronic gear function and is active in all synchronization operating modes.

The master axis gear can be altered in operational mode. It supports speed adjustment when operational.

Note: In the case of position-controlled axes (cams, phase-synchronous axes) the absolute position reference to the master axis is lost during a dynamic change of the master axis gear.

3.3 Speed synchronization

In this mode, the following axis runs at speeds synchronous to the master axis. The ratio is fixed by the transmission ratio.

Using the fine adjustment, the transmission ratio can be changed in very small increments, even during operation.

An additive speed can be altered with a speed offset during operation.

The following equation describes the relationship:

$$n_{Folge} = n_{Leit} \times \text{transmission ratio} \times (1 + \text{fine adjustment}) + \text{speed offset}$$

Fig. 3-7: Speed synchronization equation

whereby:

n_{Folge}: speed of following axis

n_{Leit}: speed of master axis

gear ratio:

Slave drive rotation / Lead drive rotation

(S-0-0237 / S-0-0236)

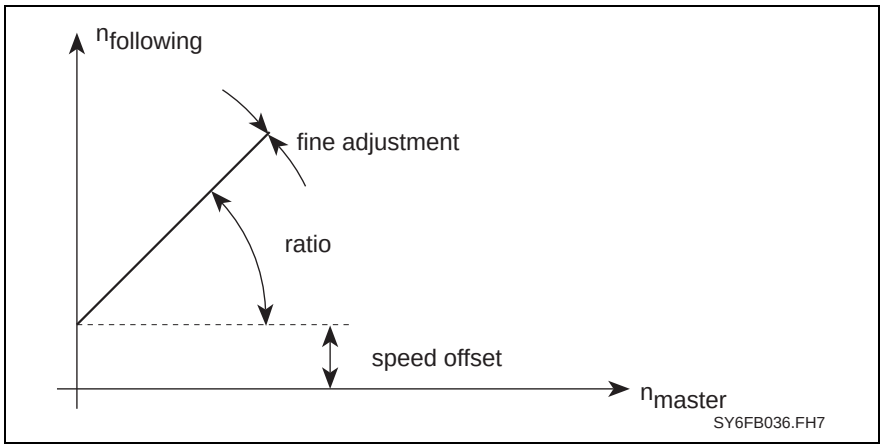


Fig. 3-8: Speed synchronization

One of the parameters "fine adjustment" (A-0-0060) or "velocity synchronization - speed offset" (A-0-0031) can be altered during operation using the jogging inputs. The parameter "jogging mode with speed synchronization" (A-0-0013) is used to determine which of these three parameters is affected by the jogging inputs.

Applications

Web transport

Pulling, cooling and simple transport roll feeds do not need a reference position to the master axis. They are operated speed-synchronously. Web speed is preset at the circumference of the roll feed with electronic gears.

To generate, e.g., a web extension or to influence web tension, an advance or backward slip can be set. Using parameter "fine adjust", speed can be changed starting from the preset gear ratio in increments of 0.01%.

Master axis gear is set to 1:1.

Synchronizing the impression cylinder

The impression cylinders run with speeds synchronous to the printing cylinders or to the master axis.

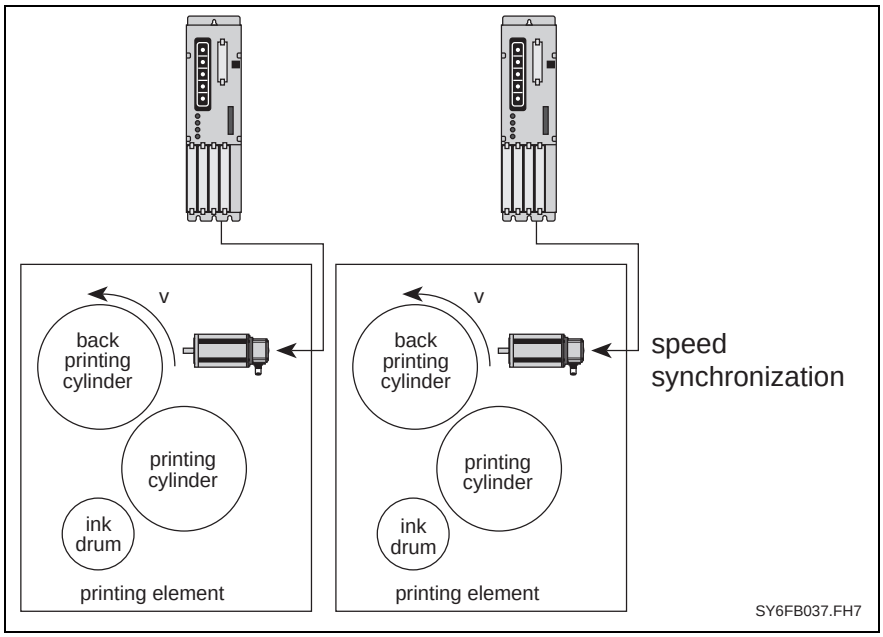


Fig. 3-9: Example: following axis in speed synchronization (impression cylinder)

3.4 Phase synchronization

In phase synchronization mode there is a fixed positional relationship between the master and the following axis. The gear ratio is free programmable. The phase offset between master and following axis can be modified during production.

The position of the following axis corresponds to the following:

$$\varphi_{\text{Folge}} = \varphi_{\text{Leit}} \times \text{transmission ratio} + \text{phase offset}$$

Fig. 3-10: Phase synchronization equation

with:

φ_{Folge}: Position of the following axis

φ_{Leit}: Position of the master axis

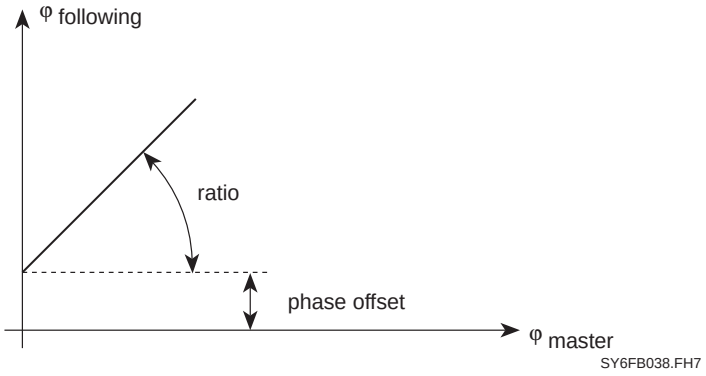


Fig. 3-11: Phase synchronization

Applications

Processing with absolute master axis reference

Of primary importance in product processing (printing, perforating, stamping, cutting, folding and so on) is precise positioning.

Operating mode phase synchronization establishes the position reference to the master axis. During operation, the phase offset to the master axis can be moved. The electronic gear ratio, on the other hand, fixes the product cycle (the format) permanently.

Master axis gear is set to 1:1.

Example

Printing cylinder sychronization

The printing cylinders must be synchronized to each other or the master axis when running. Parameter "phase offset" can be used for adjustments in the in-phase register during operation.

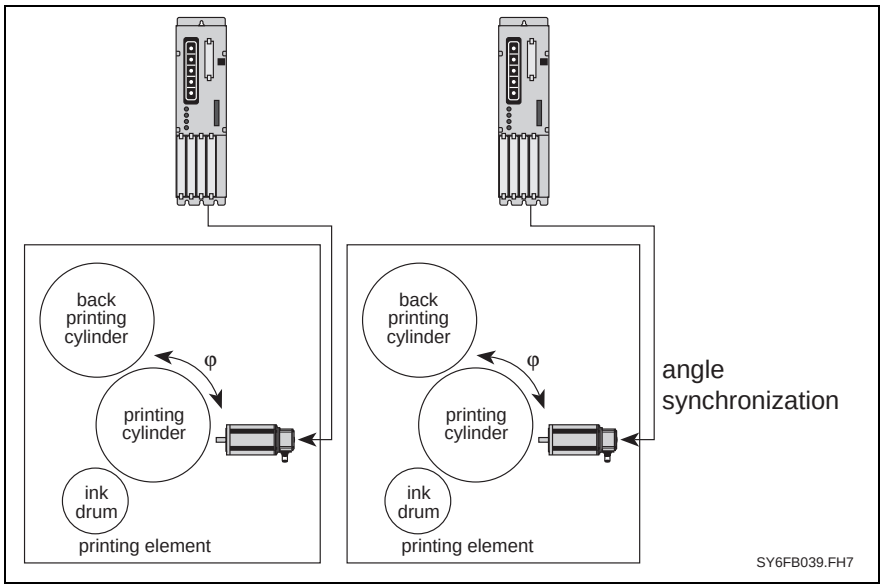


Fig. 3-12: Example: Following axis in phase synchronization (printing cylinder)

Transport rolls

Transport rolls feeding a constant web length need rigid control behavior on the part of the position control in combination with a speed adjustment to correct lengths.

In mode 'phase synchronization' the drive runs position controlled. Format length is set with the electronic gear. During operation, the required section length can be corrected or a preprinted web can be adjusted by changing the speed of the transport roll via the master axis gear in very small increments.

Effective phase offset

The effective phase offset is generated from several components. A resulting value is calculated on the CLC and is transmitted to drive parameter "position command value additional" (S-0-0048).

The "position command value additional" is generated from the following components:

- parameter "position command offset" (A-0-0004)
- parameter "group command value additive 1" (A-0-0132), scaled with "group command value 1 - weighting" (A-0-0134)
- parameter "group command value additive 2" (A-0-0155), scaled with "group command value 2 - weighting" (A-0-0157)
- output of CLC internal register controller.

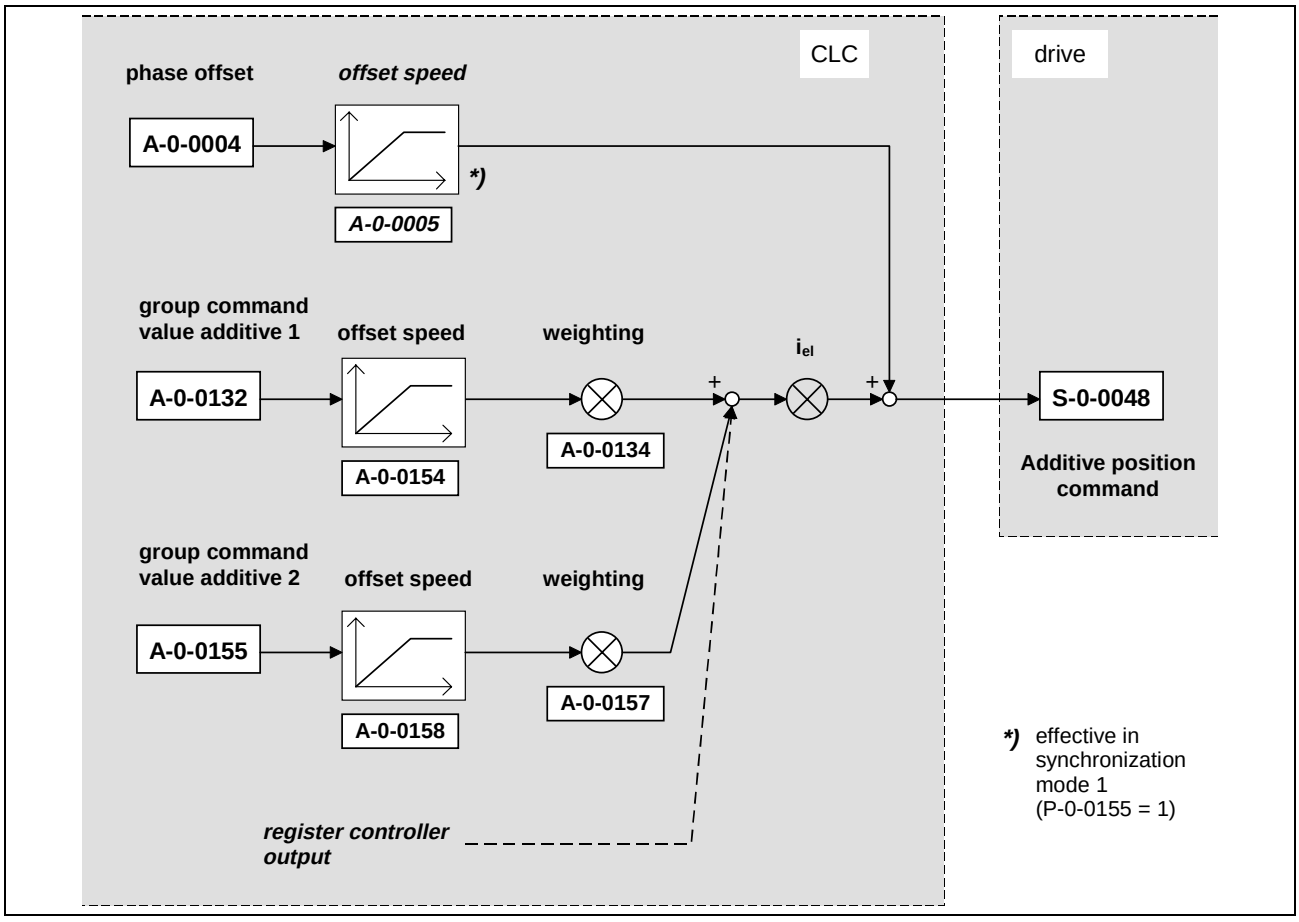


Fig. 3-13: Generating "position command value additive"

The "position command offset" (A-0-0004) always affects *one* drive. The speed offset (A-0-0005) is effective only if synchronization mode 1 is selected (see also "Synchronization mode 1", 3-45). The "position command offset" may be altered by the jogging inputs of the jogging function.

Group command values can affect several axes.

The output of the CLC internal register controller is only active if the register control is enabled. If no register controller has been configured, then this component is set to ’0’.

Using group command values

With a group command value it is possible to distribute *one* additive position command value to several axes. This allows to change the phase offset for several drives simultaneously.

To assign drives to the group command values, the drive addresses are entered in parameter

- "group command value 1 - drive addresses" (A-0-0133) for "group command value additive 1" (A-0-0132) resp.
- "group command value 2 - drive addresses" (A-0-0156) for "group command value additive 2" (A-0-0155).

The drive group must be defined in the drive which receives a group command value from e.g. a PLC.

Configuration example

The "position command value additive" is to be simultaneously changed in three drives with addresses 3, 4 and 11. The PLC transmits "group command value additive 1" (A-0-0132) to drive 3.

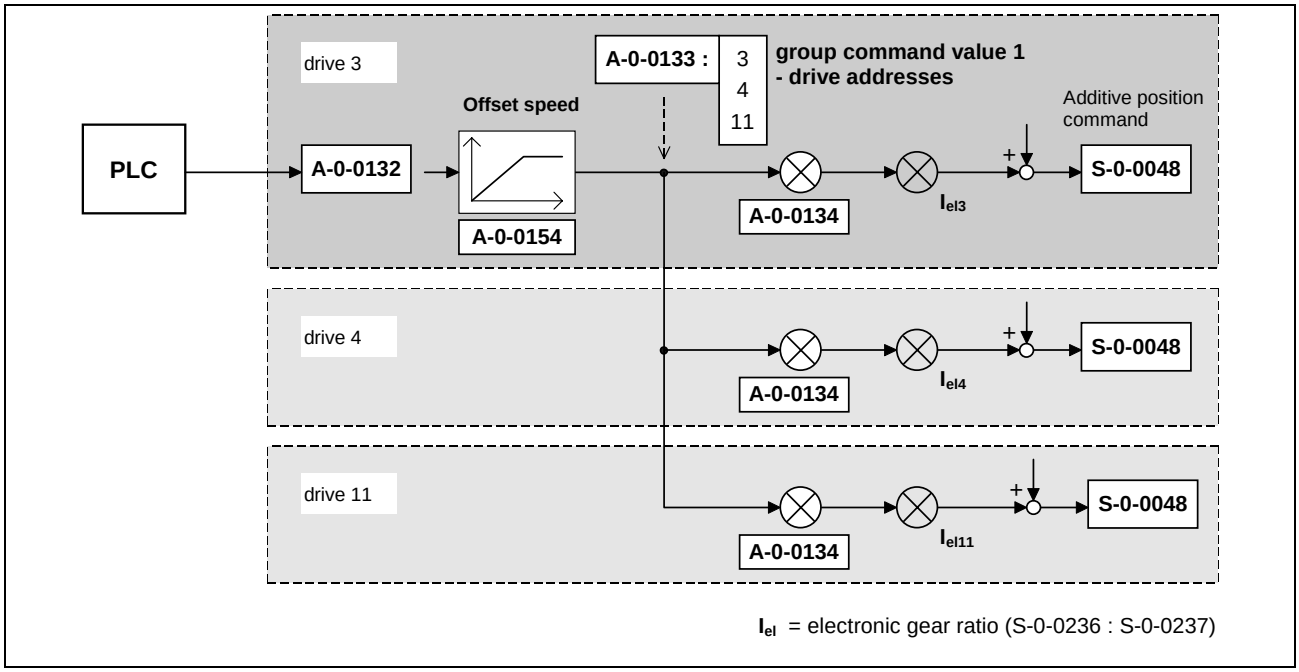


Fig. 3-14: Example: group command value configuration

Notes on project planning

Up to eight drives may be assigned to *one* "group command value additive *n*".

***One* drive may be assigned to one *one* "group command value additive 1" and *one* "group command value additive 2". It is not possible to assign two group command values 1 or two group command values 2 to *one* drive.**

To simplify data handling on the PLC it is possible to always layout "Group command value *n* - drive addresses" (A-0-0133, A-0-0156) for eight drives. To remove a drive from the group overwrite its address with '0'.

Example

A group is originated with addresses 1 to 8.

- A-0-0133 = 1 2 3 4 5 6 7 8

Remove drive 3:

- A-0-0133 = 1 2 **0** 4 5 6 7 8

Note: If the additive component A-0-0132 is to effect only one's own drive, then the address of this drive must be entered in "group command value 1 - drive addresses".

Application example

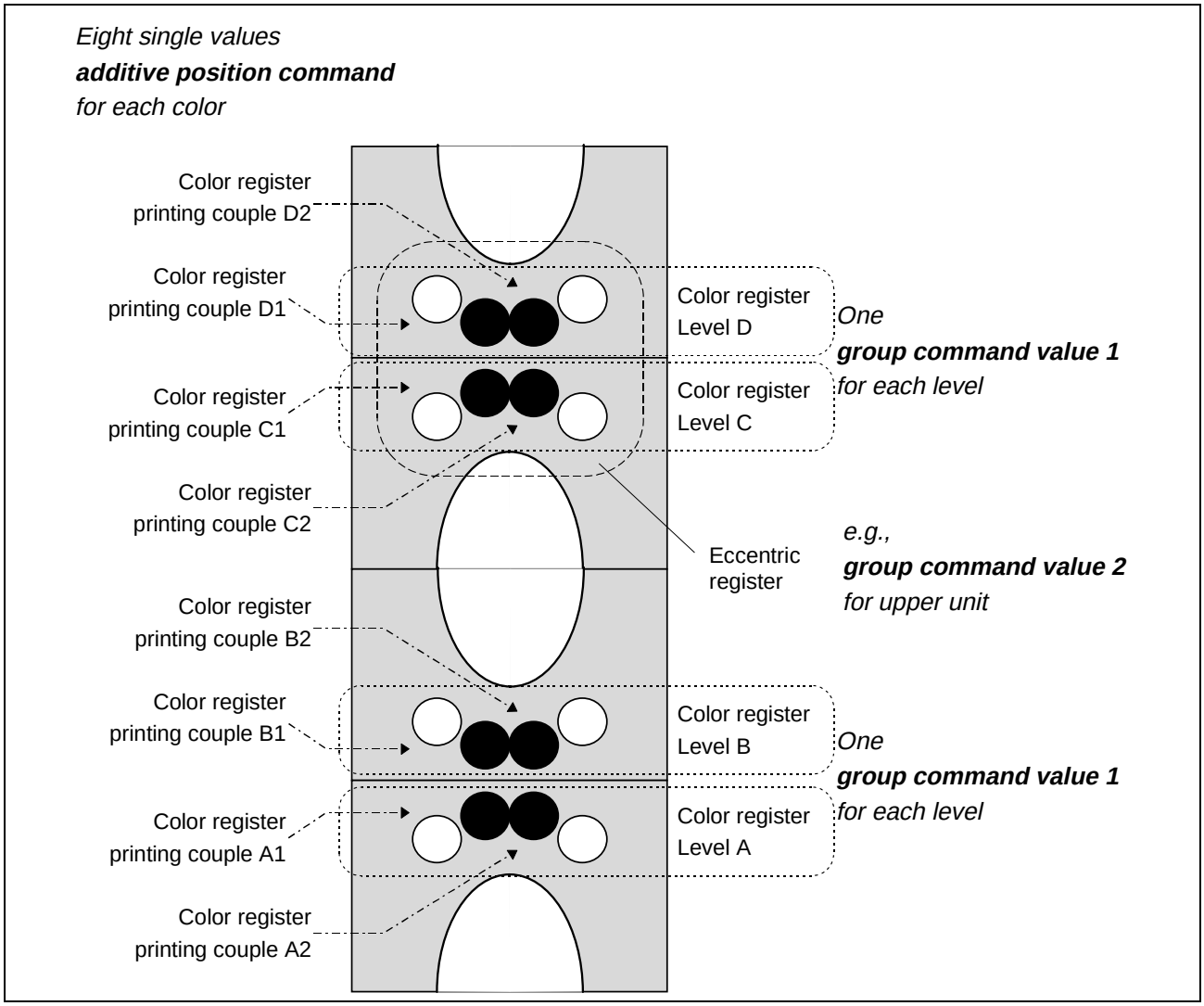

Eight single values
additive position command
for each color
Color register printing couple D2
Color register printing couple D1
Color register printing couple C1
Color register printing couple C2
Color register printing couple B2
Color register printing couple B1
Color register printing couple A1
Color register printing couple A2
Color register Level D
Color register Level C
Color register Level B
Color register Level A
Eccentric register
One group command value 1 for each level
e.g., group command value 2 for upper unit
One group command value 1 for each level

Fig. 3-15: Example: Register adjustment in newspaper printing

3.5 Electronic cam

Electronic cam operating mode

There is a fixed positional relationship between the master and following axis in this mode.

This relationship is derived from the principle of the mechanical cam, but goes beyond simple imitation. This means that it is possible to convert rotary motion into rotary motion.

The electronic cam operating mode can be described in terms of the following equations:

a) When switching synchronization on (or when changing from setup to synchronization, for example), the following equation is applied absolute in the drive:

$$x_F(\varphi_L) = h \times tab(\varphi_L - \varphi_V) + x_V$$

Fig. 3-16: Function electronic cam with synchronization activation

b) As long as synchronization (cam) is active, the drive only calculates positional differences:

$$\Delta x_F(\varphi_L) = h \times \Delta tab(\varphi_L - \varphi_V) + x_V$$

Fig. 3-17: Function of electronic cam during synchronization

whereby

φ_L	ELS master - actual position value	C-0-0066	
φ_V	Phase offset - begin of profile	P-0-0061	
x_F	Command position of following axis		
h	Cam shaft distance	P-0-0093	
tab (φ)	Cam shaft profile 1	P-0-0072	or
tab (φ)	Cam shaft profile 2	P-0-0092	
x_V	position command offset	A-0-0004	

During each probe cycle, values are readout of the table and position setpoints calculated using the above equation.

Cam with finite movement

The profile of a cam with finite movement looks like this:

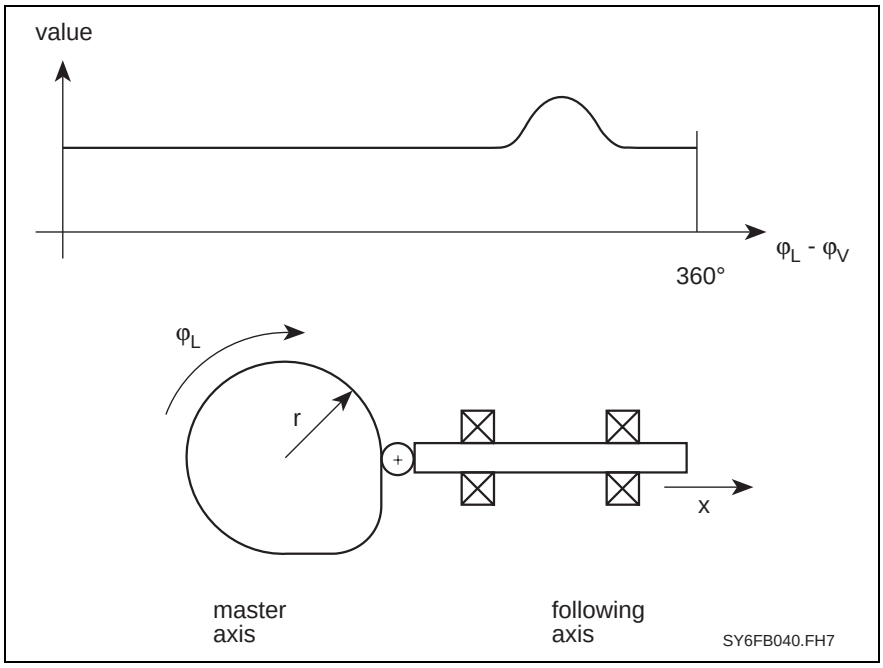


Fig. 3-18: Mechanical analog: cam

Cam with infinite movement

A profile for a cam with infinite movements looks like this:

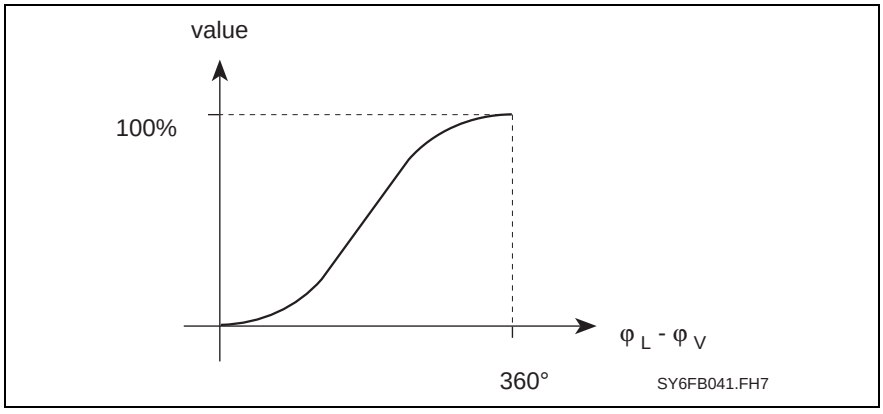


Fig. 3-19: Profile for cam with infinite movement

During each probe cycle, values are readout of the table and position setpoints calculated using the above equation.

If the limit value given on the table is exceeded in a positive direction, then the starting point of the table is not attached to the end point which has now been reached.

The following also generally applies if exceeded in a negative direction.

Together with hub h, the following curve of the cam position setpoint results with infinite movement at the load:

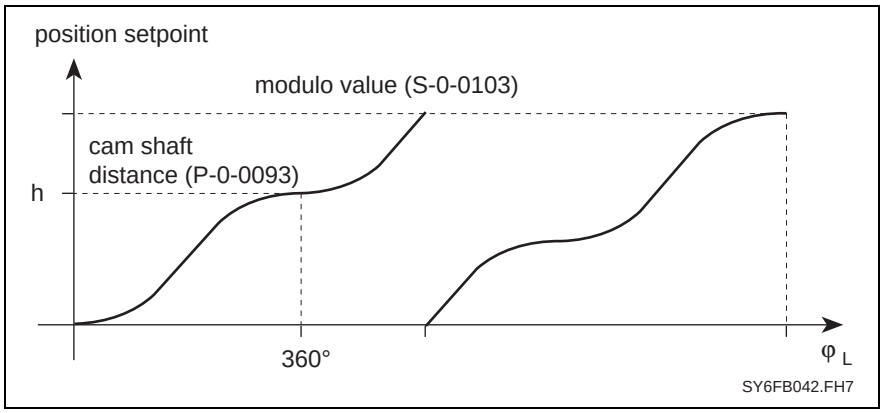


Fig. 3-20: Position command value curve with "infinite cam"

In cam mode, infinite, it is necessary to set a modulo format as a processing mode for the axis (A-0-0001).

The "modulo value" (S-0-0103) is taken into account for the display, e.g., the actual position.

Note: The "modulo value" (S-0-0103) for modulo axes must be entered in degree (e.g., 360). If the parameter is not correctly set, unwanted axis movements will occur.

A modulo value of 360 degree and a range of 360 degree guarantees that the axis will not be subject to long-term drift.

Application example "Rotating blade"

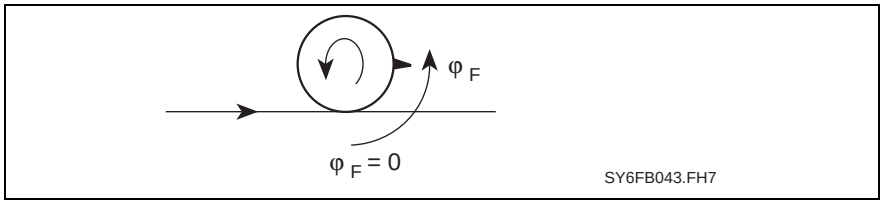


Fig. 3-21: Application example: rotating blade

The hub must equal 360° in a rotating blade application.

In the example shown, the blade cuts at φ_F = 0°. The cutting process runs at this angle. The blade must run at the same speed as the material being cut.

The table looks like this:

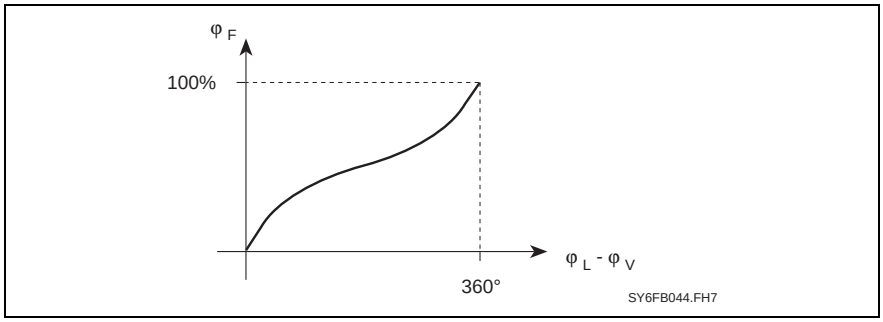


Fig. 3-22: Table - rotating blade

Application example: step-back gearbox

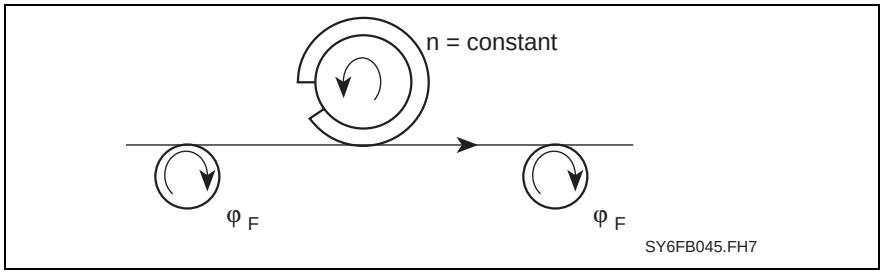


Fig. 3-23: Application example: step-back gearbox

Here, the hub equals 800°, for example.

In the "step-back gearbox application", the paper is braked at the gap between the printing plates in such a way that there is no gap on the paper.

The printing cylinder is turning at a constant speed and the transport rollers cause the correct positioning of the paper.

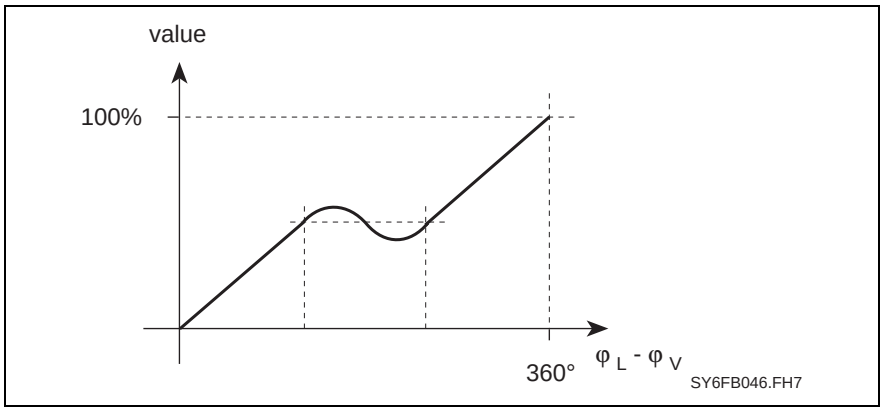


Fig. 3-24: Table for step-back gearbox

Electronic cam table

The cam profile is stored in a table. The following depicts the arrangement of the supporting points in the table. The distances between them is the constant dφ. The final table value is located at angle 360° - dφ.

The following depicts the curve of the setpoint position x_F.

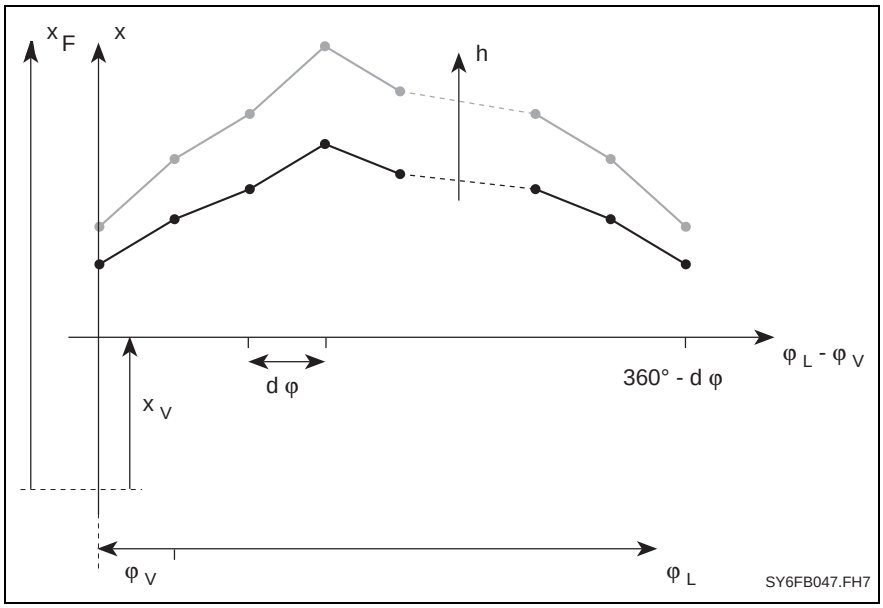


Fig. 3-25: Setpoint position curve

The cam table consists of 1024 elements distributed in equal distances over a range of φ_L = 360°.

$$d = \frac{360^\circ}{1024} \approx 0.35^\circ$$

Fig. 3-26: Element distribution for cams

The profile values have a permissible range of -200% to +200%. Maximum resolution is indicated with six places behind the decimal point.

A profile can look like this:

Number	Value
0	0.000000
1	1.100000
2	2.300000
..	
1022	0.400000
1023	0.000000

Fig. 3-27: Cam profile

The profile is made up of support points weighted in per cent. There is a linear interpolation between the support points dependent upon master axis position.

The position setpoint of the cam is determined using these values mulitplied by the hub. The hub can be changed in operating mode.

Changing between cam profile 1 and 2

The following two I/Os are intended for use when switching from "cam shaft profile 1" (P-0-0072) to "cam shaft profile 2" (P-0-0092):

Input "select cam table 2" (_E:F#.30)

Output: "cam table 2 active" (_A:F#.30)

As soon as the master axis has passed the phase "cam shaft switch angle" (P-0-0094) in either a positive or negative direction, the drive switches to the cam set in input "select cam table 2" (_E:F#.30).

The active cam is acknowledged with output "cam table 2 active" (_A:F#.30).

An example of switching from profile 1 to 2.

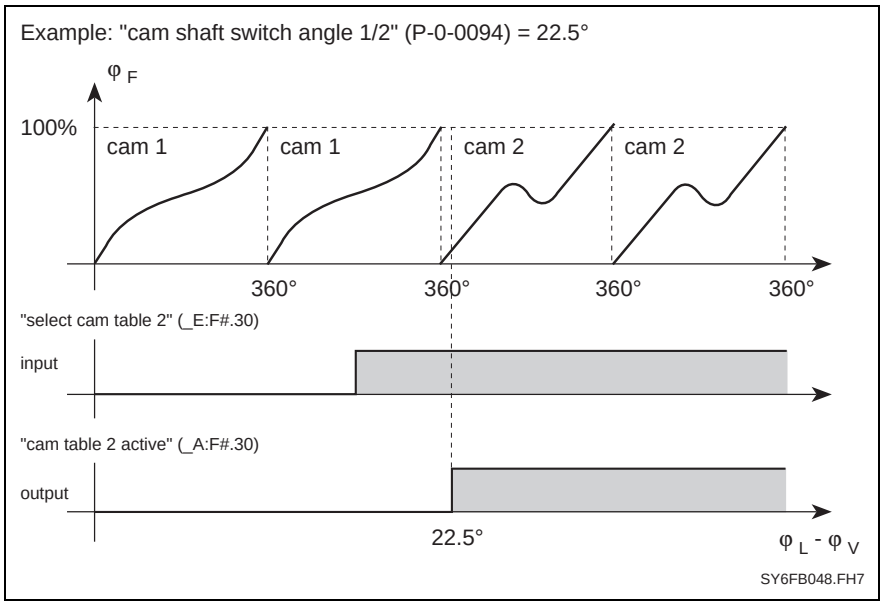


Fig. 3-28: Example for switching from profile 1 to 2

Overview of electronic cam

The following diagram offers an overview of the primary function of cam mode.

This function is run independently in the drive. The drive only needs "ELS master - actual position value" (C-0-0066) and the "position command offset" (A-0-0004) to operate. The setpoint position of the following axis is calculated from the master axis position.

The parameters shown in a dark frame can be altered in operating mode.

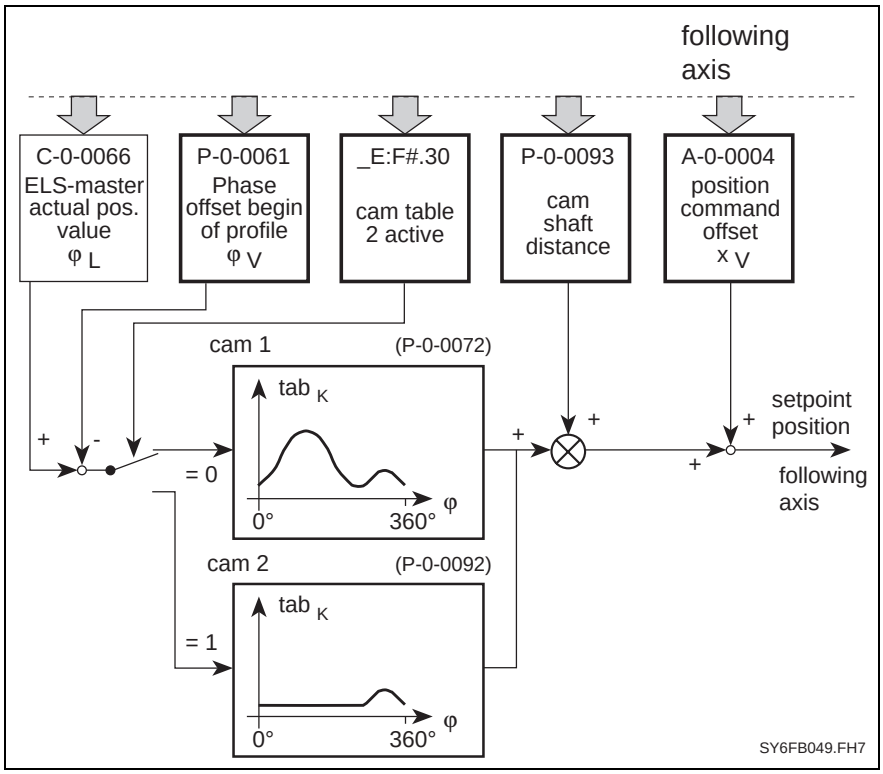


Fig. 3-29: Overview of the primary functions in electronic cam mode

Changing the hub in cam mode

The hub can be changed when in operating mode. It should, however, be noted that if synchronization is active and drive enable on, then only differences are processed. See equation 1 (see "Electronic cam operating mode", page 3-12, Point b). The motional sequence after the hub has been moved depends on when the new hub takes affect. The moment of the switch is set in parameter "Cam shaft distance switch angle" (P-0-0144). A new hub does not take effect until the master axis passes the switch angle.

Finite cam:

The following is an example of the motion sequence after the hub has been moved from 100mm to 50 mm for two different switch angles.

Example:

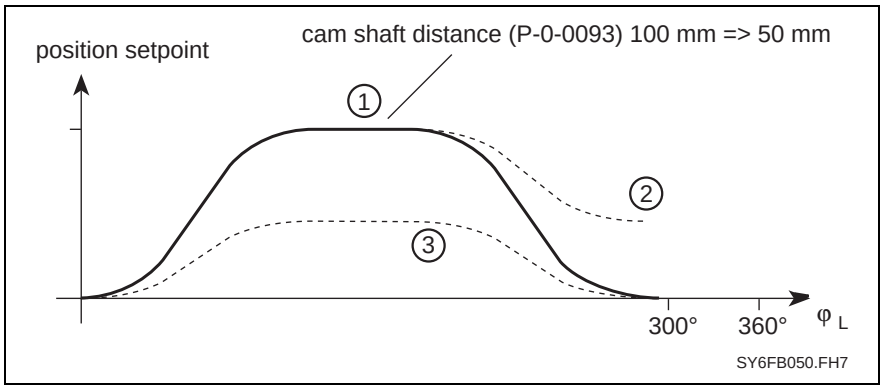


Fig. 3-30: Hub change with a finite cam

- Switch angle is 160°.

  If the hub is changed at point **1,** then the displayed line sequence **2** results.

  This behavior ensures that even in the event of jump-type changes of the hub, no jump is applied to the position command of the drive.

- Switch angle is 300°.

  If the hub is changed by degree using a table with a "zero", then the drive will run the profile labelled **3**.

Infinite cam - axis with modulo format:

If the hub is altered while in operating mode (≠ modulo value), then unwanted synchronization motions can occur upon activation of synchronization.

Note: In the case where hub ≠ modulo value it is necessary to set the axis for "relative synchronization" (see A-0-0003).

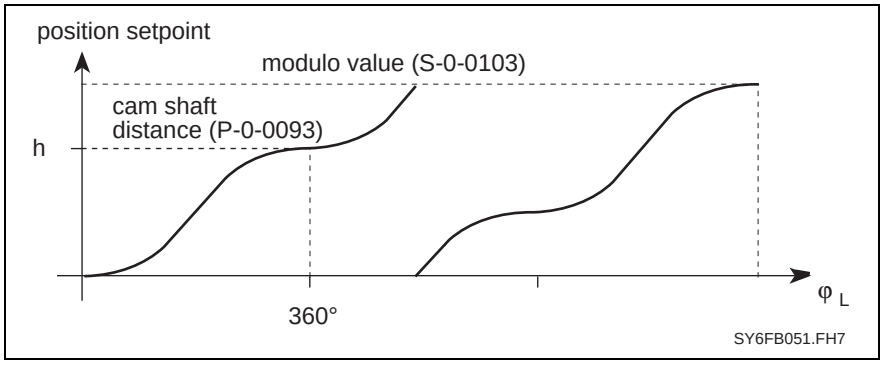


Fig. 3-31: Hub change with an infinite cam

Should "absolute synchronization" be set by mistake, then it is possible that unwanted synchronization movements can occur upon activation of synchronization.

Note: In the case of infinitely revolving axes, where the hub can be changed in operating mode, the modulo format should always be set (see A-0-0003).
⇒ Danger of unwanted axis movements!

Changing the phase offset in cam mode

The phase offset between the cam and the master axis can be changed in operating mode. The offset is set in parameter "phase offset begin of cam shaft profile" (A-0-0096). With "phase offset begin of cam shaft profile speed" (A-0-0119), the drive-internal variable "phase offset begin of profile" (P-0-0061) follows.

Binary I/Os of the electronic cam

Designation	Function
_E:F#.05	Synchronization mode
_E:F#.30	Select cam table 2
_A:F#.05	Sync. mode acknowledge
_A:F#.30	Cam table 2 active

Fig. 3-32: Binary I/Os of the electronic cam

Parameters of the electronic cam

Parameter number	Designation
A-0-0001	Axis type
A-0-0002	Position command offset - preset value
A-0-0003	Synchronization mode
A-0-0004	Position command offset
A-0-0005	Position command offset speed
A-0-0007	Incremental jogging position of following axes
A-0-0017	Position command offset - positive limit
A-0-0018	Position command offset - negative limit
A-0-0096	Phase offset begin of cam shaft profile
A-0-0119	Phase offset begin of cam shaft profile speed
A-0-0124	Cam shaft distance
A-0-0132	Group command value additive 1
A-0-0133	Group command value 1 - drive addresses
A-0-0134	Group command value 1 - weighting
A-0-0153	Jogging mode with phase synchronization
A-0-0154	Group command value 1 - offset speed
A-0-0155	Group command value additive 2
A-0-0156	Group command value 2 - drive addresses
A-0-0157	Group command value 2 - weighting
A-0-0158	Group command value 2 - offset speed
A-0-0161	Group command value 1 - positive limit
A-0-0162	Group command value 1 - negative limit
A-0-0163	Group command value 2 - positive limit
A-0-0164	Group command value 2 - negative limit
S-0-0228	Position synchronization window
P-0-0061	Phase offset begin of profile
P-0-0072	Cam shaft profile 1
P-0-0085	Dynamic phase offset
P-0-0092	Cam shaft profile 2
P-0-0093	Cam shaft distance
P-0-0094	Cam switch angle
P-0-0108	Lead drive polarity
P-0-0142	Synchronization acceleration
P-0-0143	Synchronization velocity

P-0-0144	Cam switch angle hub
P-0-0151	Synchronization window with modulo format
P-0-0154	Synchronization direction
P-0-0155	Synchronization mode

Fig. 3-33: Parameters of the electronic cam

3.6 Electronic pattern control

Primary function

A following axis working in **electronic pattern control mode** computes the position command value itself in terms of

- the position of the master axis
- tables and parameters stored in the drive
- target positions stored in the drive (these can only be cyclically changed with a pattern computer).

There is a **path-path-coupling** between the master axis and slave drive. The following drive positions within one master axis revolution to four or six target positions. If a single target position is altered, then the path-path-coupling within the range between the previous and the following target positions is also altered similarly to the stroke offset in cam mode. The path-path-coupling in the remaining range stays unchanged.

Note: Control pattern mode is only possible with absolute axes meaning that it cannot be used with modulo axes, e.g., in printing machines.

Master axis position

The master axis can assume positions **("ELS master - actual position value" (C-0-0066))** with values ranging from 0° to 360°. This range is further divided into two ranges, as depicted below:

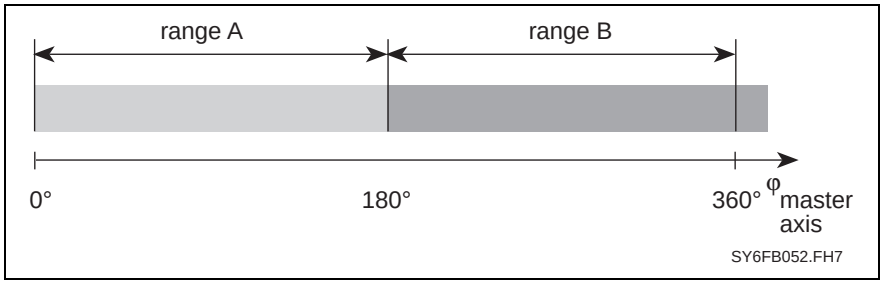


Fig. 3-34: The range of value of the master axis positions

The drive can run to two or three target positons in each of these ranges. A differentiation is made between two and three-step operating modes.

Note: Parameter "lead drive polarity" (P-0-0108) must be set for each following axis so that the rotational direction in each following axis is positive (given the set rotational direction of the master axis).

Case 1: Virtual/real master axis turning a positive direction with the machine

⇒ "lead drive polarity" (P-0-0108) = 0 (positive polarity) must be set in every drive with pattern control mode.

Case 2: Virtual/real master axis turning a negative direction with the machine

⇒ "lead drive polarity" (P-0-0108) = 1 (negative polarity) must be set in every drive with pattern control mode.

Two-step operation

The drive approaches two target positions when in two-step mode. A positioning procedure is depicted below.

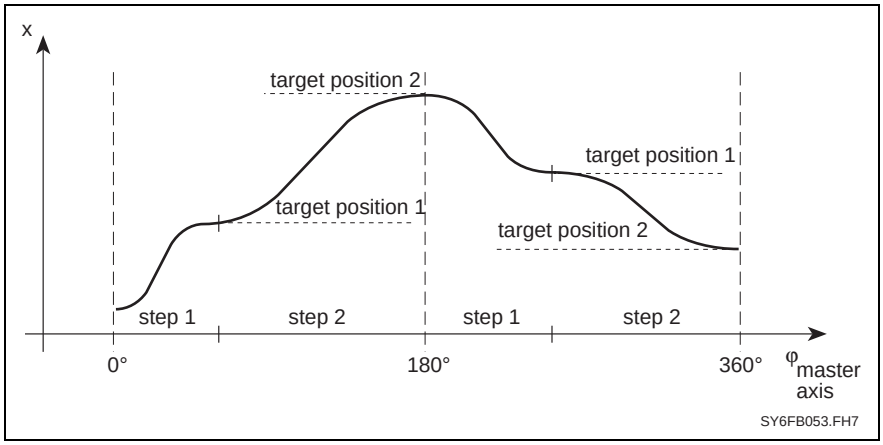


Fig. 3-35: Positioning in two-step mode

Three-step operation

The drive approaches three target positions in three-step operation. A positioning procedure is depicted below.

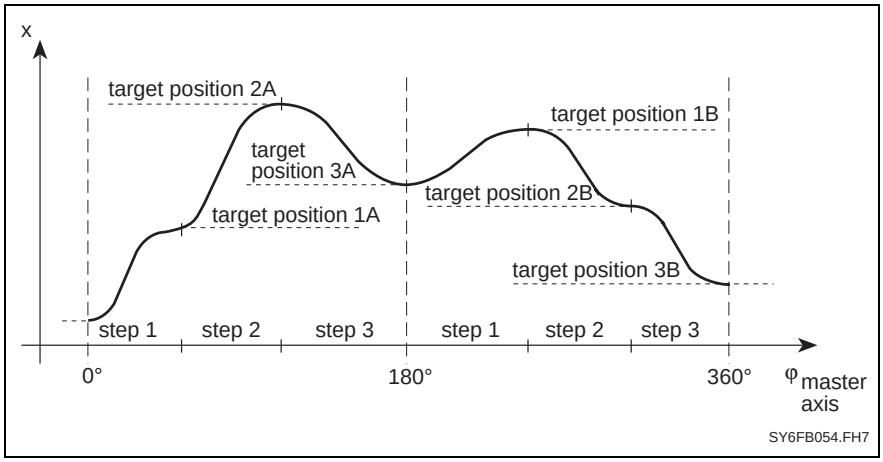


Fig. 3-36: Positioning in three-step mode

Function of the pattern control table

Tables which depict the traversing profile for a pattern control axis in standardized form are stored in the drive.

The traversing path of the current increment is derived from the difference between the present target (k) and the target position of the step just completed (k-1).

This difference is then multiplied with the standardized value taken from the table, which is dependent upon the master axis position read. It is then added to the target position (k-1). This value represents the **position setpoint** determined by the electronic pattern control.

The pattern control tables have been scaled to the number 65535 (2^{16}-1).

Each of these tables contains 512 elements. One table is depicted on a 180° range of the master axis. This means that there is a **constant distance of**

$$\frac{180^\circ}{512} \approx 0.35^\circ$$

Fig. 3-37: Distance between two support points

between the support points. The following axis interpolates between these support points. This means that the following axis runs smoothly even with **very small speeds of the master axis**.

Two pattern control tables have been defined for two-step and two tables for three-step operation.

Each of these four pattern control tables is further divided into two (two-step) or three (three-step) ranges. Each range (step) begins with 0 and ends with 1 (65535).

Tables for two-step operation

Two tables apply to two-step operation. They look like this:

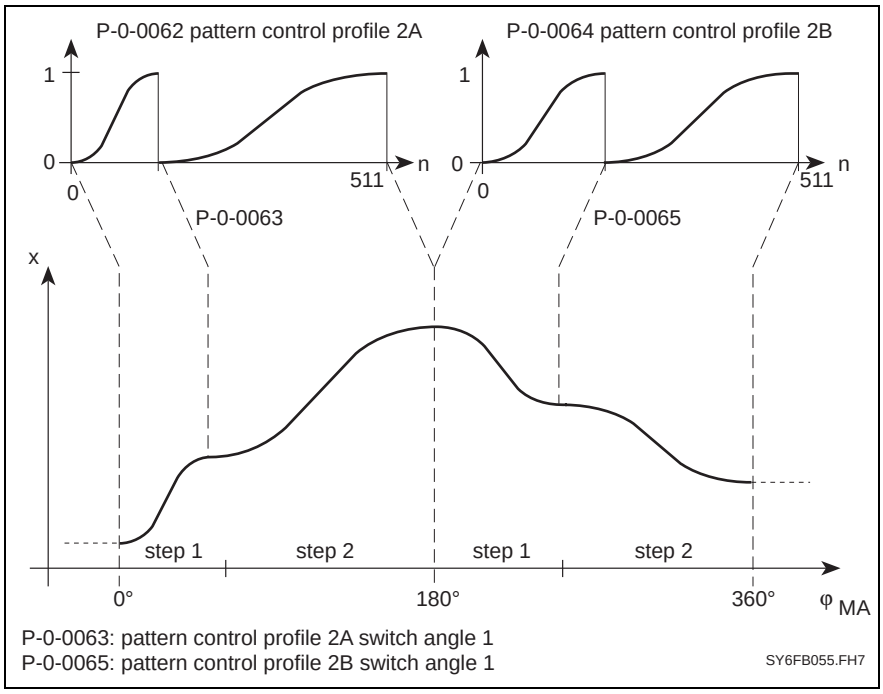


Fig. 3-38: Operating principle of the pattern control tables for two-step operation

The table consists of 512 numbers. Table 2A above can look like this:

Element number	0	1	2	3	..	167	168
Contents	0	0	2	7		65527	65532
Element number	169	170	171	172	..	509	510
Contents	65535	65535	0	1	65533	65535	65535

Fig. 3-39: Table 2A - as depicted above

Tables for three-step operation

Two tables apply to three-step operation. They look like this:

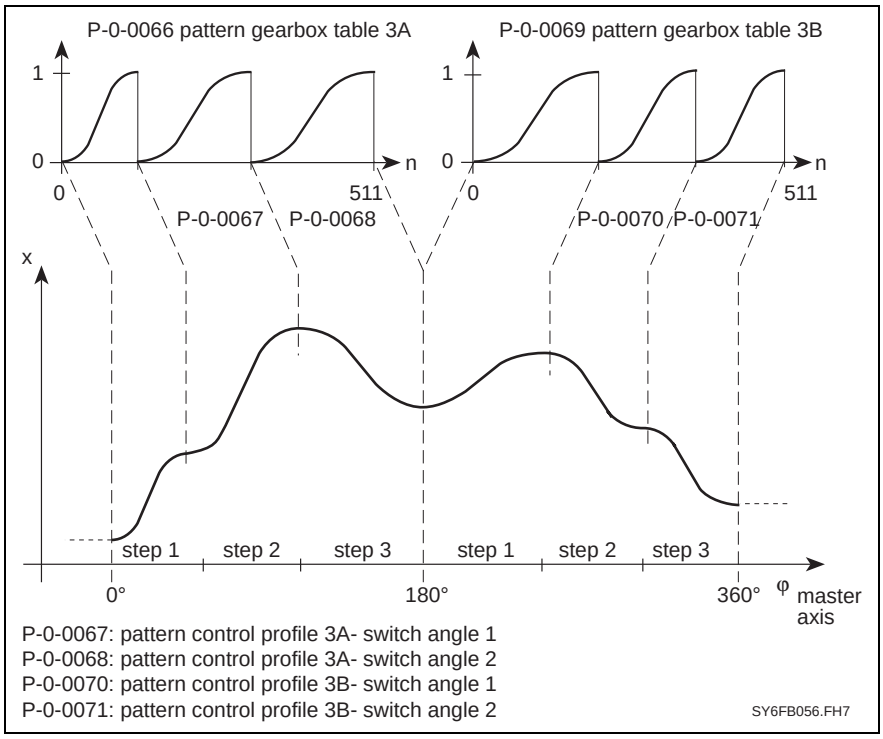


Fig. 3-40: Operating principle of pattern control tables for three-step operation

The table is made up of 512 numbers. Table 3A above can look like this:

Element number	0	1	2	..	169	170	171	172	..
Contents	0	2	7	..	65532	65535	0	1	
Element number	307	308	309	310	311	..	510	511	
Contents	65532	65535	65535	0	2	..	65533	65535	

Fig. 3-41: Table 3A - as depicted above

Threshold angles of the pattern control tables

One threshold angle belongs to each two-step table. Two threshold angles belong to each three-step table. These threshold angles given in angular degree specify the point at which the table jumps from 65535 to 0.

The following parameters have been defined for the threshold angles:

"pattern control profile 2A - switch angle 1" (P-0-0063)

"pattern control profile 2B - switch angle 1" (P-0-0065)

"pattern control profile 3A - switch angle 1" (P-0-0067)

"pattern control profile 3A - switch angle 2" (P-0-0068)

"pattern control profile 3B - switch angle 1" (P-0-0070)

"pattern control profile 3B - switch angle 2" (P-0-0071)

These threshold angles are created during initialization of the following axis and serve diagnostics or control of the tables (⇒ in preparation).

The following errors initiate an error reaction when checking the four pattern control tables:

- the number of elements of the table is uneven, 0 or 512
- the table does not start with 0
- the table does not end with 1 (65535)
- exactly one jump from 1 to 0 is not contained in a two-step table
- exactly two jumps from 1 to 0 are not contained in a three-step table

If the tables stored in the following axis are correct, then the following axis can correctly calculate the threshold angle (⇒ in preparation).

The threshold angle is calculated:

$$\varphi limit = n limit \times \frac{180°}{512}$$

Fig. 3-42: Threshold angle calculation

Example: Element no. 170 = 65535 $\Rightarrow n_{limit} = 170$

Element no. 171 = 0

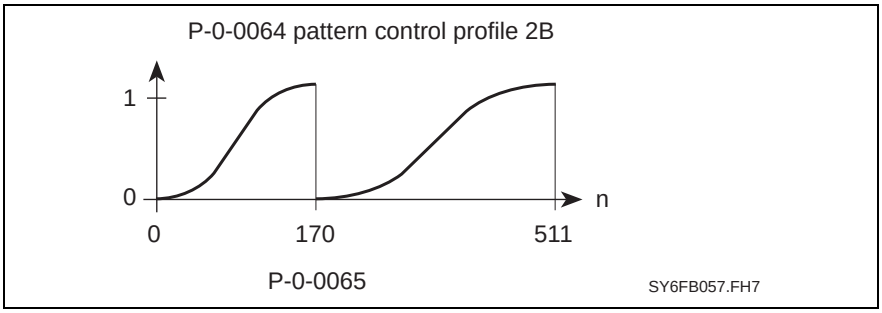


Fig. 3-43: Example: pattern control table 2B

Results:

$$P-0-0065 = nlimit \times \frac{180°}{512} = 59.7656°$$

Fig. 3-44: Results

Angle displacement - table start

Parameter **"phase offset begin of profile"** (**P-0-0061)** displaces the following axis with respect to the master axis.

Example: P-0-0061 = 330°

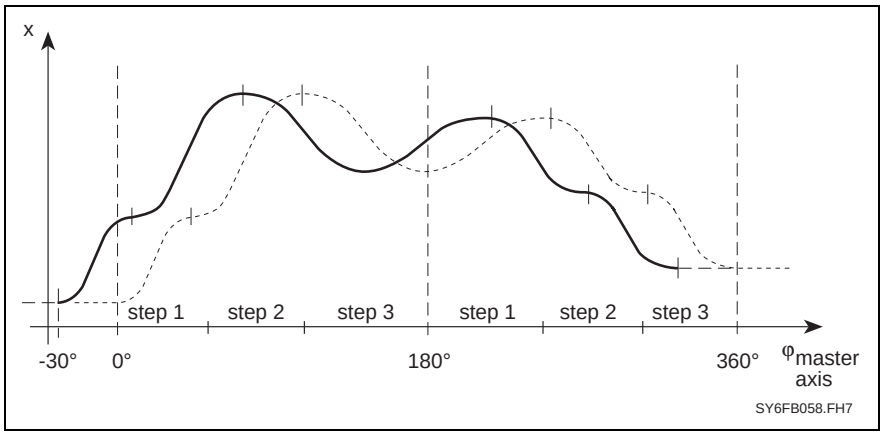


Fig. 3-45: Example fo -30° angle displacement - table start P-0-0061

Note: The angle offset profile is only taken into consideration in the drive when computing the position command value not with master data transmissions. The user must make sure that the transmission of the target positions is concluded before the target position becomes active.

Interface configuration

No pattern data transmission

Parameter **"pattern data - source" (C-0-0011)** can switch pattern data transmission off.

A drive that happens to be in electronic pattern control mode will then finish a fixed pattern. This pattern is stored in "pattern control - target position XX" (A-0-0041 to A-0-0046).

The target positions are entered directly here. Parameter "pattern control - grid dimension" (A-0-0032) and "pattern control - compensation value weighting" (A-0-0033) are not taken into account in this case.

Parameters "pattern control - step mode A" (A-0-0047) and "pattern control - step mode B" (A-0-0048) set the step mode required. If two-step is selected then "pattern control - target position 2" (A-0-0042 and A-0-0045) is not taken into account.

Parameters A-0-0041 to A-0-0048 can be changed during operation.

Using this function, it is possible to simply check the tables, for example, without using a pattern computer.

Serial interface

Parameter **"pattern data - source" (C-0-0011)** can be used to select one of the two interfaces (RS 232) for pattern data transmission.

These occupy terminals **X27** or **X28** on the CLC.

The following transmission rates can be set

- 9.6 kbaud
- 19.2 kbaud
- 38.4 kbaud

Transmission parameters

8 data bits, 1 stop bit, even parity

are preset and cannot be altered.

The connectors are assigned to the serial interfaces as follows:

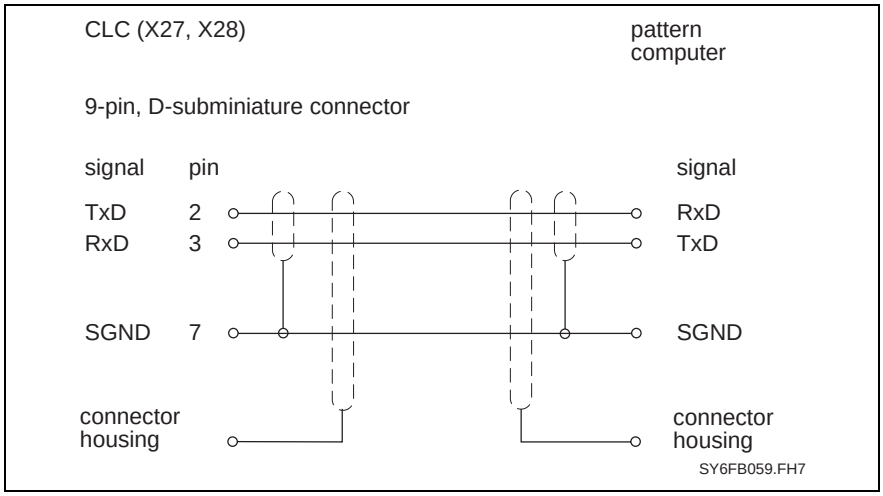


Fig. 3-46: Connector assignment of the serial interface

Pattern computer

The purpose of the pattern computer is to send pattern data to the CLC. This data must be transmitted to the CLC in a preset fashion.

Pattern data

The pattern computer transmits whole number **grid values** to the CLC. The grid value is a target position within the grid. The permissible range of values is between 0 and 4095. The grid is set in parameter **"pattern control - grid dimension" (A-0-0032).**

The pattern computer also transmits a **correction value** to the CLC. This value makes it possible to correct the target position within the grid. It can accept values between -15 and +15. This correction is weighted with parameter **"pattern control - compensation value weighting" (A-0-0033).**

The CLC processes the pattern data into target positions and sends these via the SERCOS interface to the drive.

The target position is the result of the weighted sum of the grid value and the correction value:

$$\text{target position} = [\text{grid value} + \text{correction value} \times \text{weighting comp. value})] \times \text{grid dimension}$$

Fig. 3-47: Target position

Example: "pattern control - grid dimension" (A-0-0032) = 1 mm

"pattern control - compensation value weighting" (A-0-0033) = 5.0 %

grid value = 7

correction value = -3 $\Rightarrow$ target position = 6.85 mm

Note: If master data transmission is active then the value of 1 must be set in parameter master axis gear input revolutions P-0-0156 and master axis gear output revolutions P-0-0157.

Transmission protocol

In range A it is necessary (master axis angle 0°..180°) and range B (master axis angle 0°..360°) to **always** transmit three data blocks.

Each data block contains information from the pattern computer for calculating one target position for all pattern controls - following axes connected.

The following depicts how a data block is constructed:

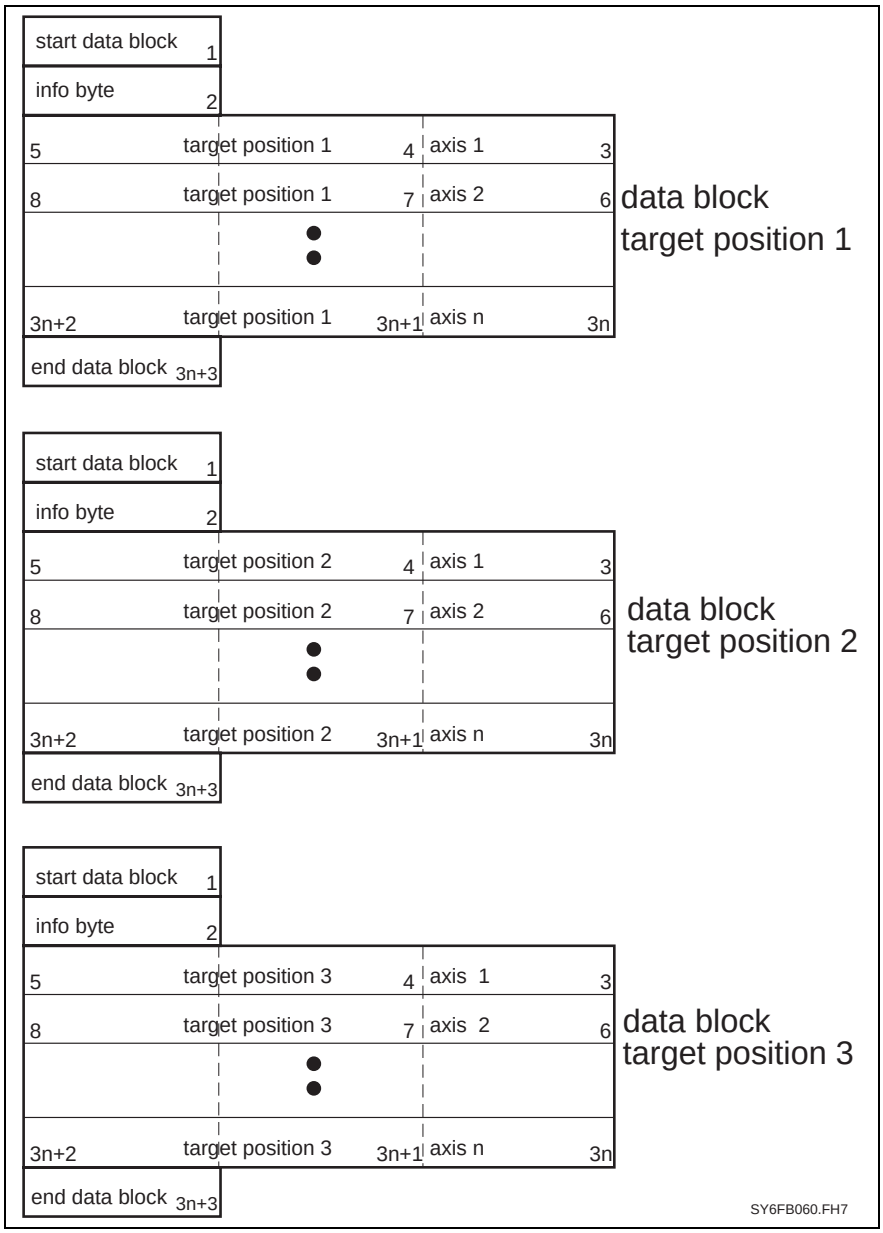

start data block 1
info byte 2
5 target position 1 4 axis 1 3
8 target position 1 7 axis 2 6
3n+2 target position 1 3n+1 axis n 3n
end data block 3n+3
data block target position 1
start data block 1
info byte 2
5 target position 2 4 axis 1 3
8 target position 2 7 axis 2 6
3n+2 target position 2 3n+1 axis n 3n
end data block 3n+3
data block target position 2
start data block 1
info byte 2
5 target position 3 4 axis 1 3
8 target position 3 7 axis 2 6
3n+2 target position 3 3n+1 axis n 3n
end data block 3n+3
data block target position 3
SY6FB060.FH7

Fig. 3-48: Construction of a data block

The target position of the second data block is ignored in two-step mode. The drive approaches the target positions specified in data blocks 1 and 2. **Data block 2 must be transmitted nonetheless!**

The following figure depicts the definition of the individual elements in the data blocks.

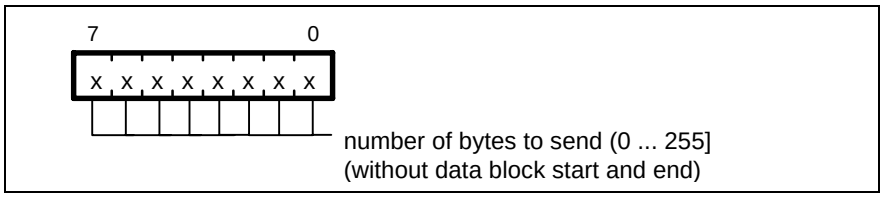


Fig. 3-49: Data block start

4 drives x 3 bytes/target position + 1 info byte = **13 bytes**

8 drives x 3 bytes/target position + 1 info byte = **25 bytes**

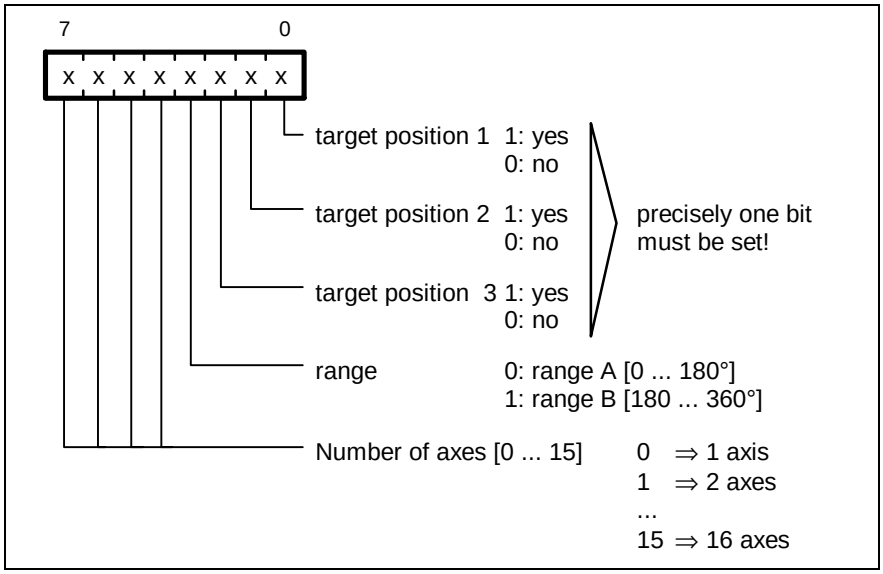


Fig. 3-50: Info byte

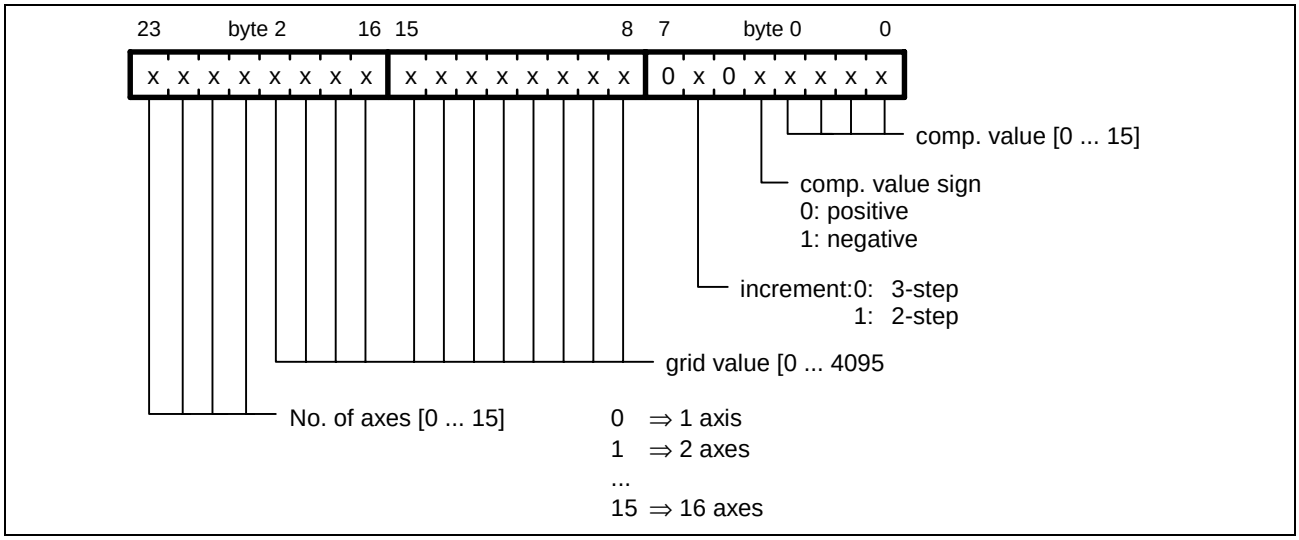


Fig. 3-51: Target position

The step mode may not be altered within the three data blocks of a range. This means that in all three blocks **either three or two-step mode** must be specified.

The three bytes of the target position are sent in the order byte **0** ⇒ **byte 1** ⇒ **byte 2**.

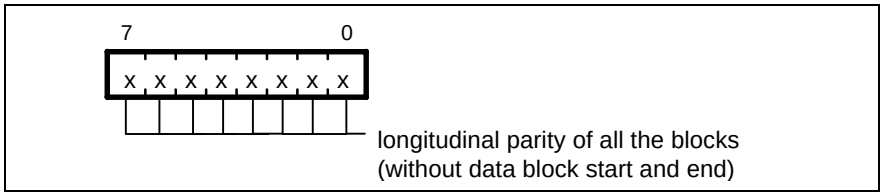


Fig. 3-52: Data block end

With the exception of the first (data block start) and the last (data block end), the checksum of all bytes is in data block end. The checksum is put together as per DIN 66219. An XOR - linking of bytes - is used.

Chronology of pattern data transmission

Parameter **"pattern data - source" (C-0-0011)** specifies the interface that the CLC controller board uses to receive pattern data. The PC bus, with a CLC-P, or one of the two interfaces, X27 or X28, is available for this purpose.

The pattern computer must always transmit **three data blocks** in advance of the next range to the CLC. This means, for example, that pattern data for range B are already being sent while sending range A.

The duration of this transmission depends upon the transmission speed of the interface selected and the number of pattern control drives. It is identified with T1 in the following figure.

Every data block is checked. An error message ensues in the event of an error. Once checked, the values are decoded and the target positions calculated. The target positions are then transmitted via SERCOS by the CLC to the drives. This process requires time, T2.

The **three data blocks** transmitted in this fashion determine the movement of the pattern control drive during the range which follows.

The following figure depicts the chronological sequence of the pattern data transmission:

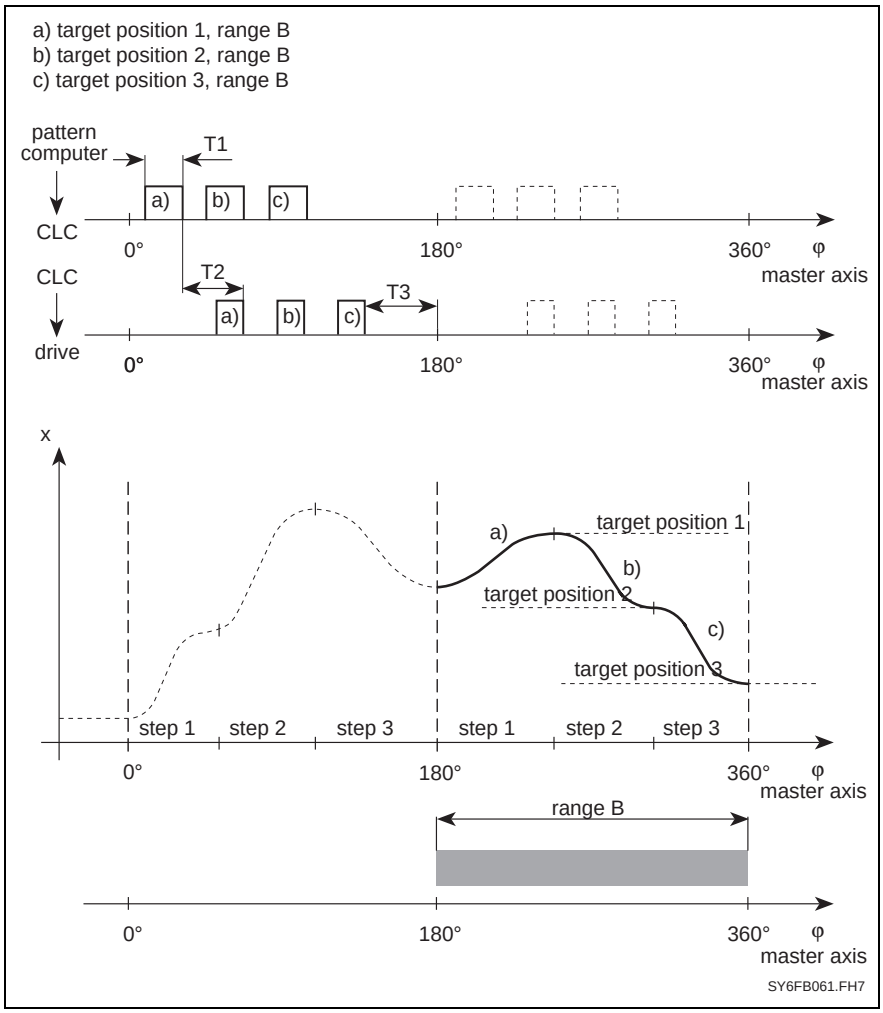


Fig. 3-53: Chronological sequence of the pattern data transmission

It is necessary to ensure that all three data blocks for range B or A are processed while in range A or B, and the drive receives three target positions.

Should the drive receive less than three target positions within one given range, this is the case for example with T3<0, then the drive will signal an error (Error 75, see "CLC error messages", page 3-39).

The drive will also signal an error if target positions for range A are transmitted while in range A (Error 74, see "CLC error messages", page 3-39). The same applies to range B.

The structure of the electronic pattern control

The following figures schematically depict the functional structure of the electronic gearbox. The pattern computer transmits the pattern data to the CLC in advance. It processes these to target positions and then transmits them to the drive.

There, the target positions are written into a shift register.

Using the "lead drive position" (P-0-0053) and the selected step mode, the status logic selects the correct table. The shift register is moved one increment ahead after each step, upon reaching the target position. With a two-step mode, for example, the shift register is moved two steps ahead after the first target position.

The traversing path of the current increment is derived from the difference between the present target position to be approached (k) and the target position of the step just completed (k-1).

This difference is then multiplied with the standardized value taken from the table, which is dependent upon the master axis position read. It is then added to the target position (k-1).

As input variable, both the status logic and the table use the master axis position to which the parameter "phase offset begin of profile" (P-0-0061) was added. The addition of this angle causes a displacement of the table with respect to the master axis position.

As input variable, both the status logic and the table use the master axis position to which the parameter "phase offset begin of profile" (P-0-0061) was added. The addition of this angle causes a displacement of the table with respect to the master axis position.

A permanent position offset is produced via parameter "position command offset" (A-0-0004) by means of

- jogging inputs
- or by directly writing into this parameter.

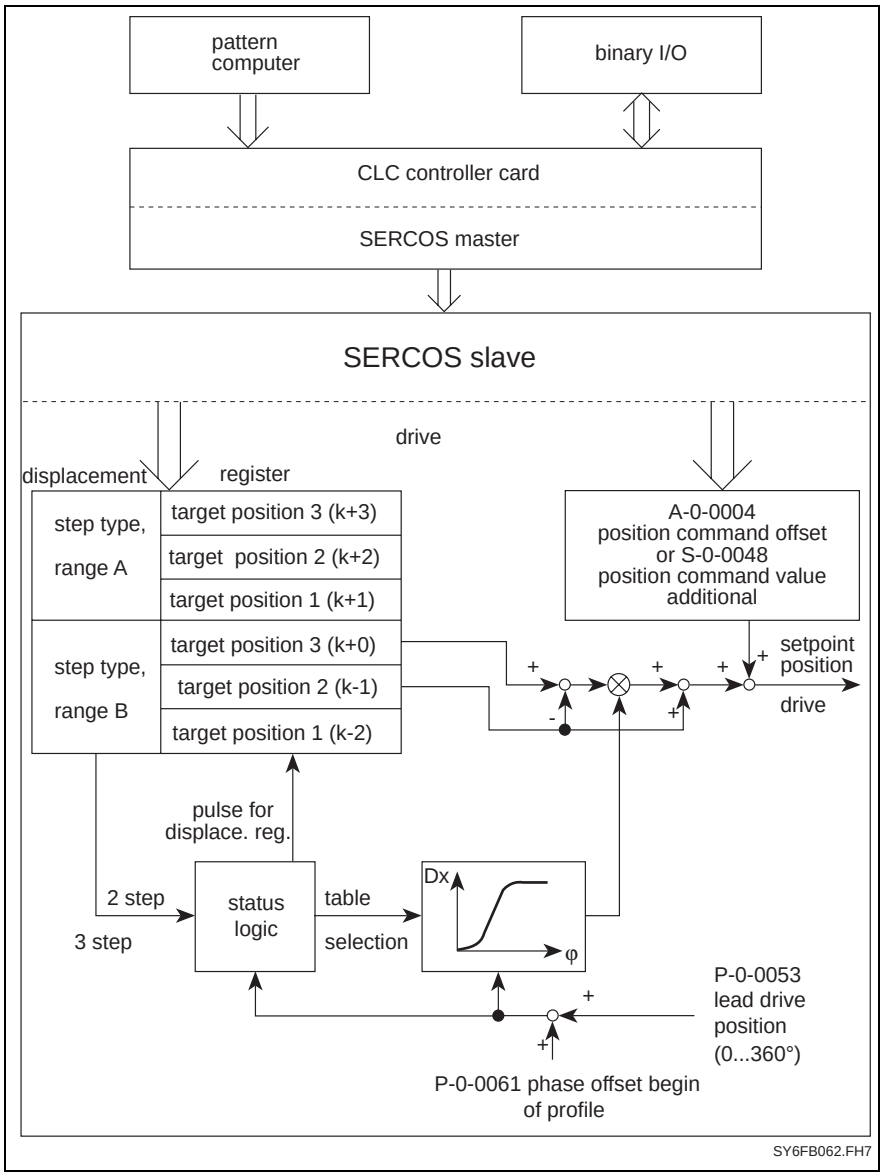


Fig. 3-54: The construction of an electronic pattern control

Status logic

The status logic is depicted in the figure below in the form of a status diagram. Switching into the next state is dependent upon both the specified step-mode and the "lead drive position" (P-0-0053) or threshold angles.

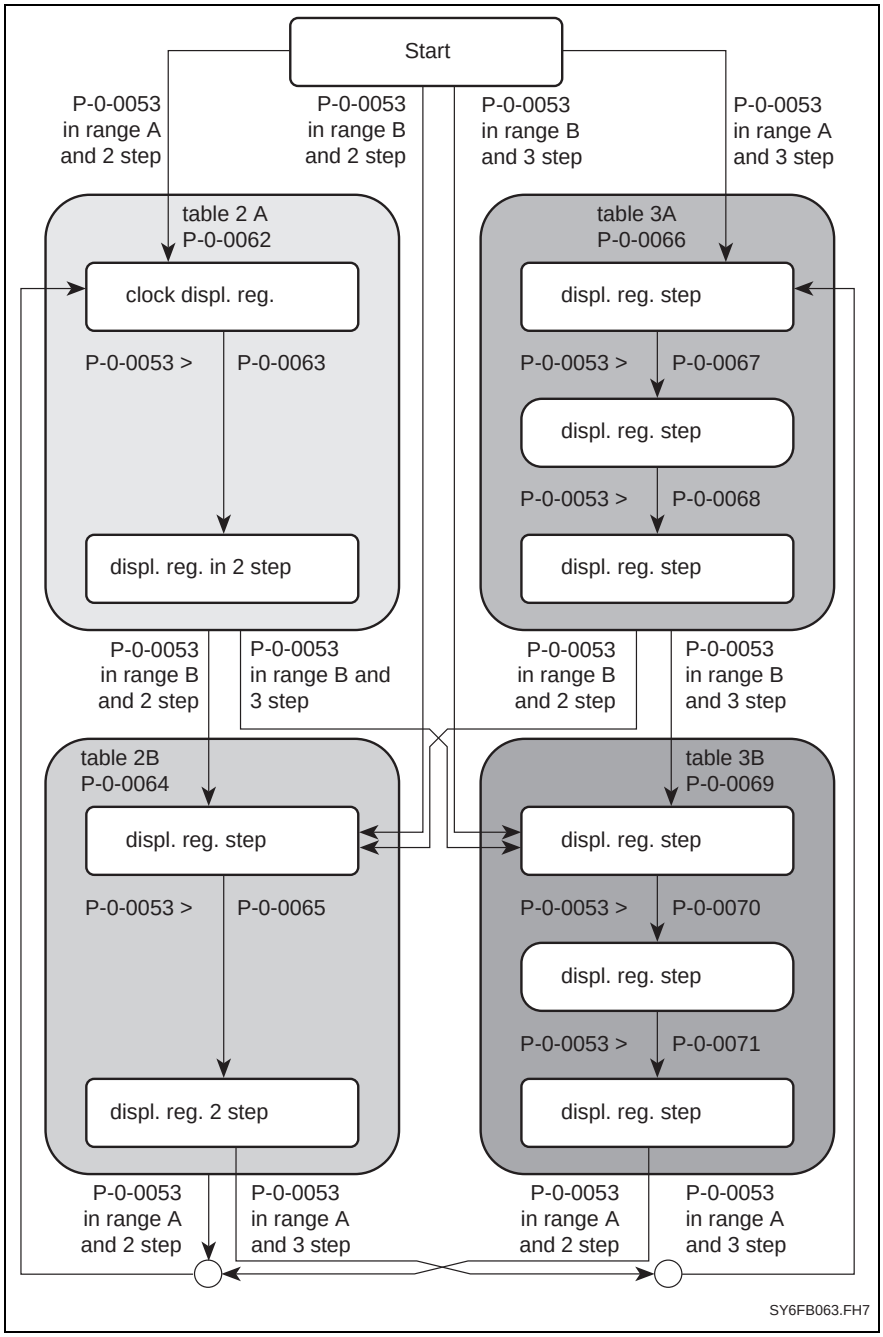


Fig. 3-55: Status logic

Monitoring the target positions

The target positions received from the **pattern computer** are stored in parameters A-0-0050 to A-0-0055.

The reason for storing these target positions is to support the diagnostics of the telegrams transmitted from the pattern computer. In the event of an error, the drive can approach a target position other than the one transmitted by the pattern computer.

The CLC checks the calculated target position for validity, taking parameter "position command value" (A-0-0004) into account.

Two criteria are monitored:

- The width of the increments resulting from two sequential target positions is limited.
- Target positions are limited, i.e., pattern limit values are monitored.

If the target positions need to be limited, then the limited value is transmitted into the shift register of the drive.

Limiting the increments

Parameter "pattern control status" (C-0-0014) can activate increment limiting. Bit 15 is used for this purpose.

bit 15 = 0: increment width not monitored

bit 15 = 1: increment width monitoring active

The CLC checks every value sent by the pattern computer as to whether the width of the increment has been exceeded. Parameter **"pattern control - limits between received target positions" (A-0-0049)** contains the limit values for this purpose.

An acknowledged overtravelling causes the drive to stand still in its last valid position.

Monitoring increment width has priority over maintaining pattern limit values. In other words, maximum increment width must always be maintained.

The following figure depicts the allocation of the six elements of parameter "pattern control - limits between received target positions" (A-0-0049) which support limit value input, if bit 15 = 1.

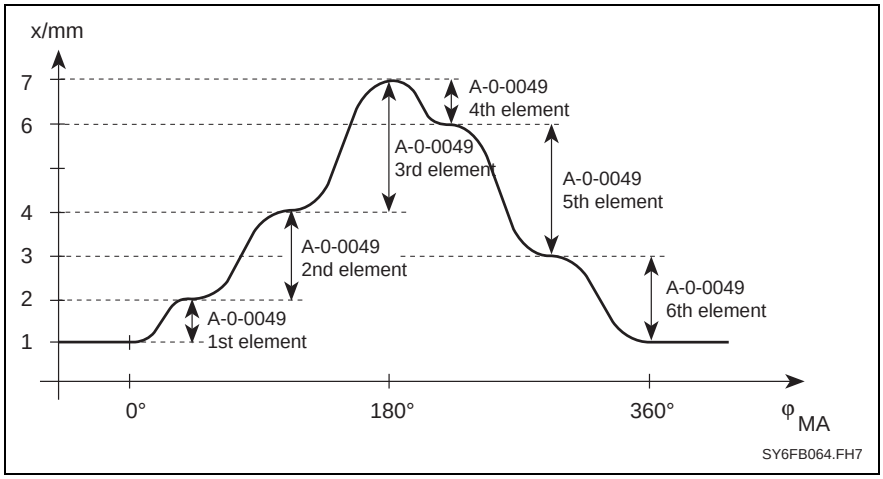


Fig. 3-56: Allocation of the elements of parameters A-0-0049

The following depicts how the pattern control behaves if the threshold value is exceeded. The relevant parameters in this case are:

A-0-0049, Element 3 = 2.9 mm

A-0-0049, Element 4 = 10 mm

A-0-0049, Element 5 = 10 mm

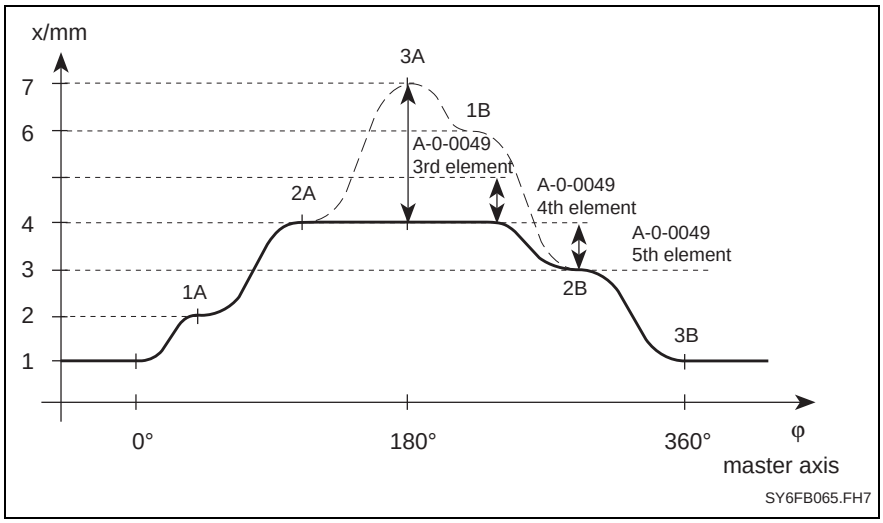


Fig. 3-57: Response to overtravelling increment width threshold (two examples)

The affects of the pattern limit values

Parameters "negative/positive pattern limit" (A-0-0039/A-0-0040) describe the maximum path to be traversed by a pattern control axis.

With the use of bit 14 in parameter "pattern control status" (C-0-0014) the error reaction can be selected.

bit 14 = 0: drive remains in last valid position if pattern limit values exceeded

bit 14 = 1: drive moves to maximum or minimum position in grid if pattern limit values exceeded

The compensation value is also taken into account and retained int he presence of an error.

Example: A positive overranging of the pattern limit value C-0-0014: bit 14 = 0, bit 15 = 0

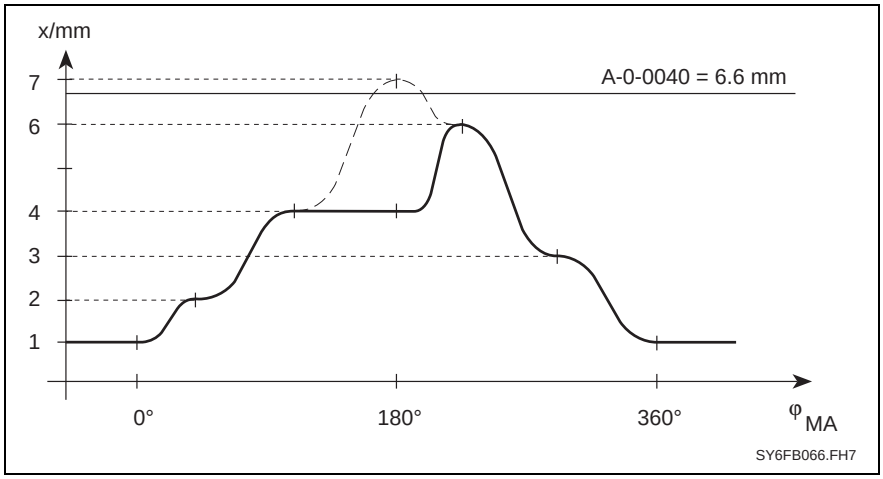


Fig. 3-58: Error reaction: drive at standstill

Example: A positive overranging of pattern limit value C-0-0014: bit 14 = 1, bit 15=0.

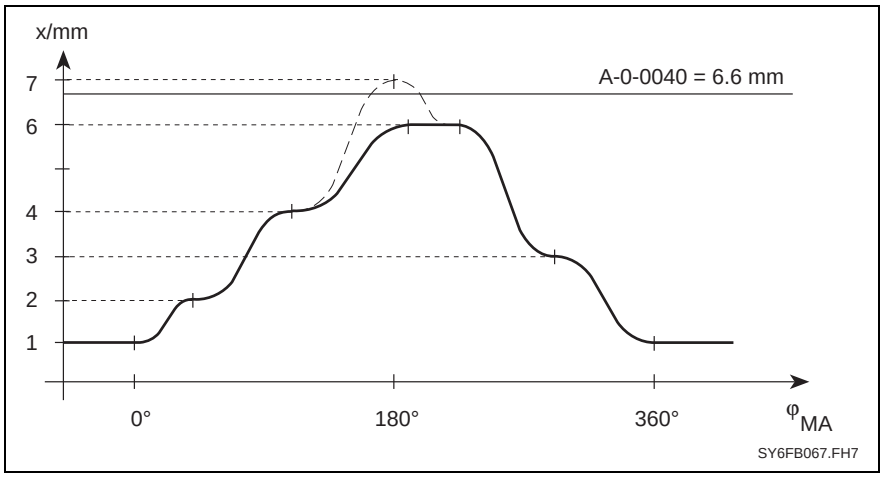


Fig. 3-59: Error reaction: greatest possible movement of the drive within grid

Pattern control parameters

All the relevant parameters for the electronic pattern control are listed below. For details see "SYNAX Parameter Description".

Parameter number	Designation
C-0-0011	Pattern data source
C-0-0014	Pattern control status
A-0-0001	Axis type
A-0-0002	Position command offset presetting
A-0-0003	Synchronization mode
A-0-0004	Position command offset - target value
A-0-0005	Position command offset speed
A-0-0007	Incremental jogging position of following axis
A-0-0017	Position command offset - positive limit
A-0-0018	Position command offset - negative limit
A-0-0032	Pattern control - grid dimension
A-0-0033	Pattern control - compensation value weighting
A-0-0039	Negative pattern limit
A-0-0040	Positive pattern limit
A-0-0041	Pattern control - target position 1A
A-0-0042	Pattern control - target position 2A
A-0-0043	Pattern control - target position 3A
A-0-0044	Pattern control - target position 1B
A-0-0045	Pattern control - target position 2B
A-0-0046	Pattern control - target position 3B
A-0-0047	Pattern control - step mode A
A-0-0048	Pattern control - step mode B
A-0-0049	Pattern control - limits between received target positions

A-0-0050	Pattern control - received target position 1A
A-0-0051	Pattern control - received target position 2A
A-0-0052	Pattern control - received target position 3A
A-0-0053	Pattern control - received target position 1B
A-0-0054	Pattern control - received target position 2B
A-0-0055	Pattern control - received target position 3B
A-0-0132	Group command value additive 1
A-0-0133	Group command value 1 - drive addresses
A-0-0134	Group command value 1 - weighting
A-0-0154	Group command value 1 - offset speed
A-0-0155	Group command value additive 2
A-0-0156	Group command value 2 - drive addresses
A-0-0157	Group command value 2 - weighting
A-0-0158	Group command value 2 - offset speed
A-0-0161	Group command value 1 - positive limit
A-0-0162	Group command value 1 - negative limit
A-0-0163	Group command value 2 - positive limit
A-0-0164	Group command value 2 - negative limit
S-0-0048	Position command value additional (for diagnostics only)
P-0-0061	Phase offset begin of profile
P-0-0062	Pattern control profile 2A
P-0-0063	Pattern control profile 2A - switch angle 1
P-0-0064	Pattern control profile 2B
P-0-0065	Pattern control profile 2B - switch angle 1
P-0-0066	Pattern control profile 3A
P-0-0067	Pattern control profile 3A - switch angle 1
P-0-0068	Pattern control profile 3A - switch angle 2
P-0-0069	Pattern control profile 3B
P-0-0070	Pattern control profile 3B - switch angle 1
P-0-0071	Pattern control profile 3B - switch angle 2
P-0-0085	Dynamical phase offset
P-0-0142	Synchronization acceleration
P-0-0143	Synchronization velocity
P-0-0151	Synchronization init window for moduloformat
P-0-0154	Synchronization direction
P-0-0155	Synchronization mode

Fig. 3-60: Pattern control parameters

CLC error messages

Errors that occur in conjunction with a serial interface are signalled by the CLC. The CLC also checks the data received from the pattern computer for plausibility.

The errors are placed as binary signals onto the internal outputs of the CLC.

The following error messages are defined:

"Pattern control serial interface overtravel"

This message is produced when the interface assembly of the CLC is overtravelled.

"Pattern control serial interface parity error"

This message is produced with a parity error of the interface assembly of the CLC.

Possible causes:

- varying interface settings between CLC and pattern computer

"Pattern control serial interface (frame error)"

This message is produced with a frame error of the interface assembly of the CLC.

"Pattern control longitudinal parity error"

This message is produced if the longitudinal parity in the protocol of the pattern data is incorrect:

Possible causes:

- faulty arithmetic algorithm in the pattern computer,
- stoachastic transmission error on the serial line or
- insufficient description of the dual port RAM with a CLC-P.

"Pattern data incorrect sequence"

The sequence of the transmitted pattern data is monitored by the CLC. The following sequence must be maintained:

Target position 1A, 2A, 3A, 1B, 2B, 3B, 1A, 2A, ...

It is, however, permitted to repeat the entire transmission of three data blocks. That means that the following sequence can result:

Target position 1A, 2A, 3A, **1A, 2A, 3A**, 1B,2B, 3B, 1A, 2A, ...

Any other sequence is not permitted and will trigger an error reaction.

"Pattern data setpoint pos. limit value overtravelled, positive"

The target position calculated from the grid value is greater than parameter "positive pattern limit" (A-0-0040).

"Patter data setpoint pos. limit value overtravelled, negative"

The target position calculated from the grid value is smaller than parameter "negative pattern limit" (A-0-0039).

"Pattern data maximum increment width exceeded"

The increment width, i.e., the difference between two target positions, is greater than the limit value specified in parameters A-0-0041 to A-0-0046.

"Pattern control error"

This signal represents the summary of all possible errors which are in anyway related to the pattern control and detected by the CLC.

"Pattern control data buffer overtravelled"

The input buffer for the pattern data is organized linearly on the CLC.

Three complete data blocks are stored there.

The number of bytes received is too large.

"Pattern data start byte error"

The number of bytes of a pattern data block to be sent is defined in data block start. Add the number 2 to this value (for data block start and end), then you have the total number of bytes of this data block.

Due to the pattern data telegram specification, this number is always a multiple of three. The CLC therefore checks the first byte using this criterion.

"Pattern data target position equivocal"

Bits 0 to 2 of the info byte define the target position.

Precisely one bit must be set. If none or several bits have been set, then this error message is generated.

"Pattern data number of axes faulty"

The CLC compares the actual number of pattern data received with the number specified in data block start. If this number does not agree, then this error message is generated.

3.7 Establishing absolute synchronization

In operating modes

- phase synchronization
- electronic cam
- electronic pattern control

a following axis runs with a fixed angular relationship, synchronously to the master axis.

A difference is made between **relative** and **absolute** synchronization.

Difference between relative and absolute synchronization

Relative synchronization

The absolute angular settings of master and following axis are not taken into account.

The following axis basically satisfies the following equation:

$$\varphi_{Folge,k} = \Delta\varphi_{Folge,k}(\Delta\varphi_{Leit}) + \varphi_{Folge,k-1}$$

Fig. 3-61: Following axis equation (relative synchronization)

whereby:

φ_{Folge}: following axis position

φ_{Leit}: master axis position

k: current calculating cycle

k-1: most recent calculating cycle

Synchronization is based on the present master axis and following axis position. The following axis makes no adjustments.

Absolute synchronization

The absolute settings of master and following axis are taken into account.

The following axis basically satisfies the following equation:

$$\varphi_{Folge} = \Delta\varphi_{Folge}(\varphi_{Leit})$$

Fig. 3-62: Following axis equation (absolute synchronization)

whereby:

φ_{Folge}: following axis position

φ_{Leit}: master axis position

When establishing absolute synchronization, it is necessary for the following axis to generally make some adjustment. The following example should clarify this behavior.

Example: **Establishing relative and absolute sychronization**

Operating mode: synchronization

ratio = 1

angle offset = + 45°

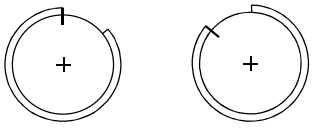
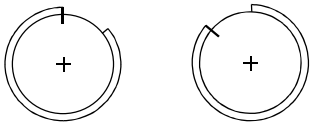
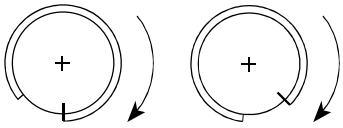
operating state prior to activation: synchronization ratio = 1 "position command offset" (A-0-0004) = +45°		Both axes are in a random position.
After activation of relative sychronization:		The position has not been changed by switching relative synchronization on.
After the master axis has rotated 180°		The following axis has rotated with the master axis in terms of the ratio. With the example here, the ratio = 1, and the following axis has rotated 180°.

Fig. 3-63: Relative synchronization

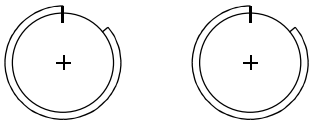
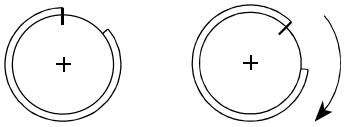
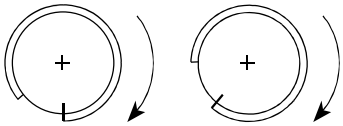
Operating state prior to activation of synchronization = 1 "position command offset" (A-0-0004) = +45°		Both axes are in a random position.
Absolute synchronization is now activated. Position of axis after synchronization:		Activating absolute synchronization, means the following axis executes a sychronization movement to be able to set the correct phase offset. It is assumed that the following axis is referenced, or an absolute measuring system has been set.
After rotation of master axis by 180°		The following axis is now moving synchronous to the master axis.

Fig. 3-64: Absolute synchronization

Dynamic synchronization

Activating synchronization requires that the following axis and the master axes both are at standstill.

Synchronization is drive-guided and occurs independently of the initial state of either following or master axis.

Speed adjustments during synchronization

During the first step, the speed of the following axis is sychronized to that of the master axis.

The following depicts this first step:

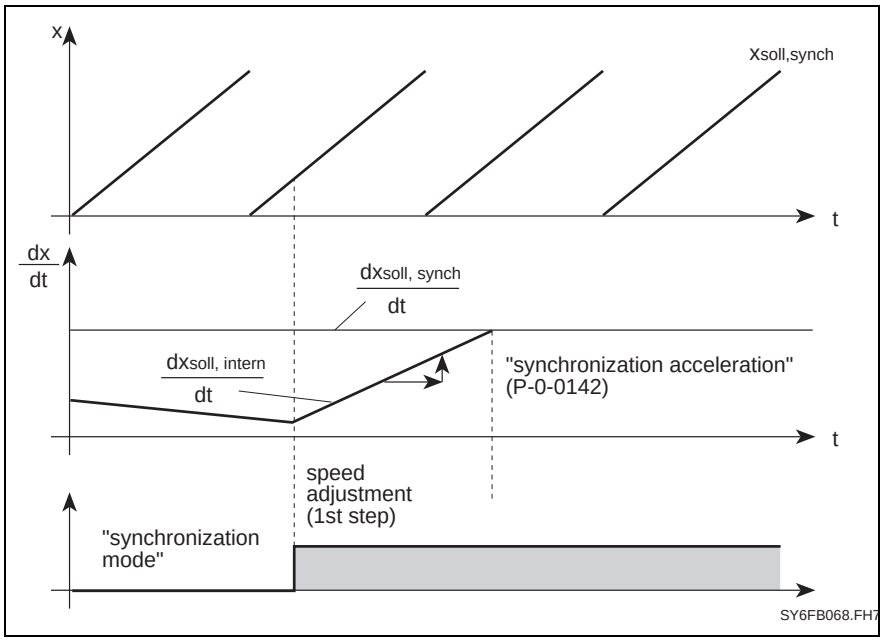


Fig. 3-65: Example of 1st step: matching of speeds during synchronization

The example shows a following axis in the act of braking, i.e., at the start of synchronization neither speed nor acceleration of the following axis is equal to 0.

At the start of command acceleration, synchronization directly goes to the value set in parameter "sychronization acceleration" (P-0-0142).

There is no jerk limit.

The first sychronization step has been concluded once the internally generated speed ($dx_{soll,\ intern}/dt$) is equal to the synchronized speed ($dx_{soll,\ synch}/dt$).

Position adjustments during sychronization

As part of the second step, the following axis reduces the position error to the master axis.

The following axis continues to internally generate position command values. As part of this process, the following axis superimposes a ramp over the position command value profile. This ramp is determined by the following parameters:

- "synchronization acceleration" (P-0-0142) and
- "synchronization velocity" (P-0-0143).

The following depicts the second sychronization step:

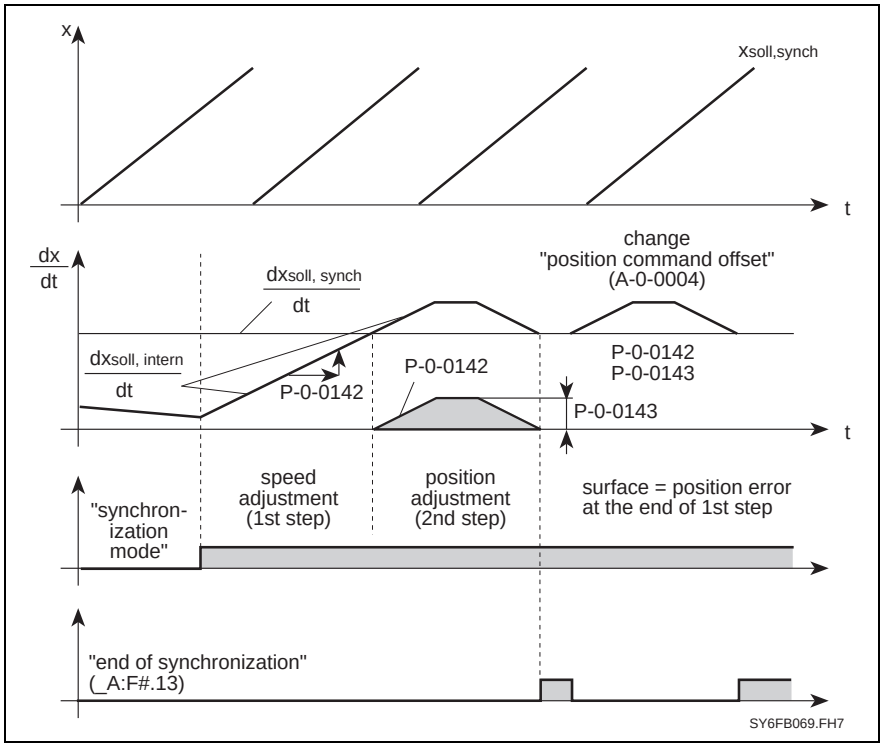


Fig. 3-66: Example of 2nd step: position adjustments during sychronization with standard application

The hatched surface under the ramp equals the position error upon completion of the first step.

There is no jerk limit.

The second synchronization step is completed once the internally generated position ($x_{soll,\ intern}$) is equal to the sychronized position.

With the following changes of "position command offset" (A-0-0004) the parameter

- "synchronization acceleration" (P-0-0142) and
- "synchronization velocity" (P-0-0143)

are used to follow-up in standard applications. Standard application means "synchronization mode 0", which is selected with parameter

- "synchronization mode" (P-0-0155) = 0.

Synchronization mode 1

If "synchronization mode 1" is selected (P-0-0155=1), then once the absolute synchronization is established, the following parameters become uneffective:

- "synchronization acceleration" (P-0-0142),
- "synchronization velocity' (P-0-0143),
- "synchronization window for modulo format" (P-0-0151) and
- "synchronization direction" (P-0-0154).

A change of "position command offset" (A-0-0004) is given to the position controller after it has been filtered at the drive with a PT1 filter. The time constant of this filter is set in parameter "filter time constant additional pos. command" (P-0-0060).

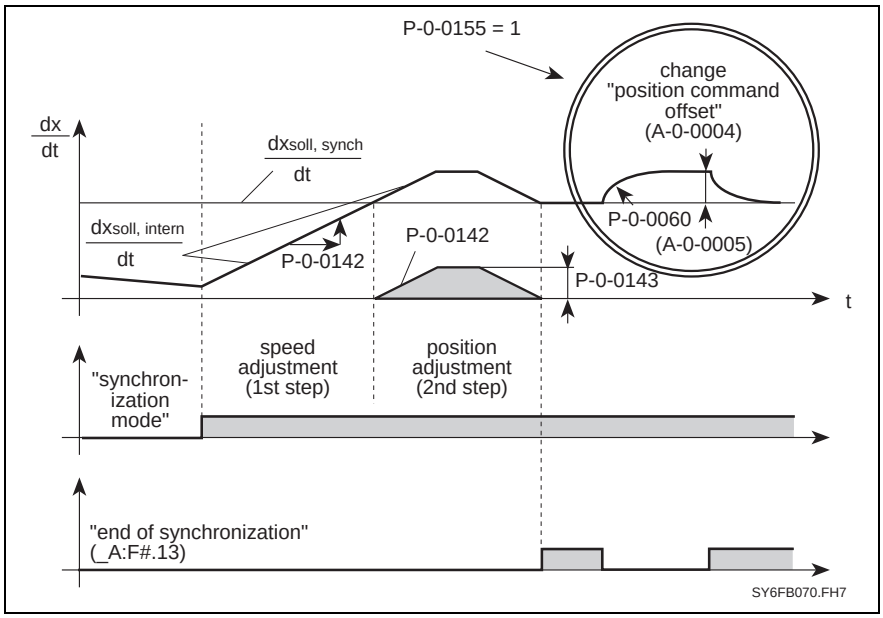


Fig. 3-67: Example: position adjustment with synchronization mode 1

The adjustment speed for the phase offest, in this case, must be set in parameter "position command offset speed" (A-0-0005).

Note: In register control applications, "synchronization mode 1" must be selected.

Synchronization direction

The direction of sychronization is fixed by parameter "synchronization direction" (P-0-0154).

If the distance of the axis to the synchronized position is less than "synchronization init window for modulo format" (P-0-0151), then the shortest possible path is used, independent of P-0-0154, for sychronization.

This only fixes the direction of the ramp (shown in the picture in grey). The actual direction of movement can deviate from the set direction in the case of a rotating axis.

3.8 Setup mode

Setup mode is one of the auxiliary modes. This mode allows to position the following axis independently from the master axis.

Example: **Mounting stereotype plates to a printing cylinder**

When mounting plates to printing cylinders, it is first necessary to bring the axis into a specific position, or move it to different positions during mounting.

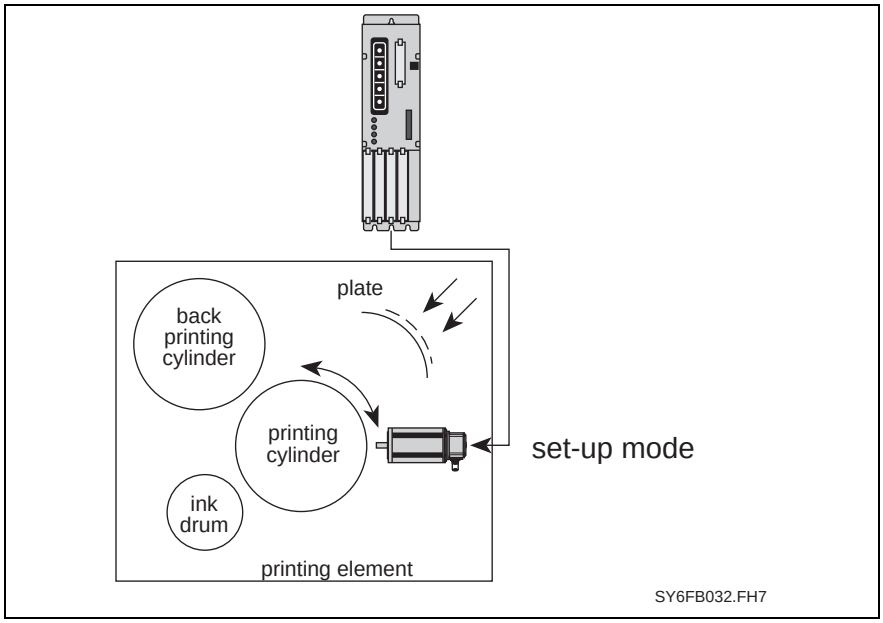


Fig. 3-68: Example: setting up the following axis - stereotype plates

A differentiation is made between the following positioning modes:

- With auxiliary mode ’set-up’ the following axis proceeds to move to absolute target positions.
- With special mode ’relative set-up’ the axis moves along a specified travel path starting from the current position (see chapter 3.10, "Free auxiliary modes (special modes)").

Function principle

Set-up mode means that a following axis can be moved to fixed positions independently of the master axis. The following functions are thus available:

- After this mode is activated, the current actual position is accepted into the position setpoint of the following axis. This option ensures that the drive stops at the position it had at the time of activation ("hanging axis without brakes").
- After this mode is activated, assume a position preset with parameters.
- Selecting different positions with binary inputs, then positioning of the axis to preset positions.
- Positioning via jogging inputs.
- Positioning via parameter transmission.
- The following axis signals that it is in position.
- Setup mode with reduced torque.

Set-up positions and set-up speed

Set-up positions are programmed via parameters "set-up position 0...3" (A-0-0056 ... A-0-0059). A separate set-up speed is assigned to each set-up position.

A set-up position can be activated via binary inputs "Select setup position bit 0/1" (_E:F#.15/16).

Activating a set-up position via binary inputs

Binary input	set-up position 0 (A-0-0056)	set-up position 1 (A-0-0057)	set-up position 2 (A-0-0058)	set-up position 3 (A-0-0059)
select setup position bit 0	0	1	0	1
select setup position bit 1	0	0	1	1

Fig. 3-69: Binary inputs for selecting setup positions

If set-up position 1, 2 or 3 is activated, the axis immediately moves to the selected position.

If set-up position 0 is activated, the CLC reads the actual position from the drive and copies this value to "set-up position 0" (A-0-0056). Set-up position 0 is then transmitted as a position command to the drive.

Note: If set-up position 0 is selected when set-up mode is active, the axis keeps the current position.

If the actual position of the drive lies outside of the parametrized minimum/maximum values, then the relevant output "ngative/positive jogging limit exceeded" (_A:F#.28/29) is set.

The presently active setup position (A-0-0056 to A-0-0059) may be changed by the jogging inputs.

Setup speeds

For each of the four setup positions, a corresponding setup speed can be set. The four setup speeds are entered in parameter A-0-0099 in the form of a list. Upon activation of a setup position, the respective speed is transmitted to the drive.

Setup position bit 1	Setup position bit 0	Setup position	Set-up speed (A-0-0099)
0	0	A-0-0056	element 1
0	1	A-0-0057	element 2
1	0	A-0-0058	element 3
1	1	A-0-0059	element 4

Fig. 3-70: Setup speeds

Activating 'absolute setup mode'

Setup mode is configured in parameter "configuration idle mode / setup mode" (A-0-0009). Binary input "set-up mode" (_E:F#.04) is used to activate this mode.

The behavior of the axis after activating setup mode depends on the selected set-up position:

- Set-up position 0 selected

  The drive remains in the position it had when setup mode was activated.

- Set-up position 1, 2 or 3 selected

  The drive immediately moves to the selected position.

Binary I/Os of the setup mode

The following I/Os are available:

Designation	Function
_E:F#.04	Set-up mode
_E:F#.15	Select setup position bit 0
_E:F#.16	Select setup position bit 1
_A:F#.04	Set-up mode acknowledge
_A:F#.14	Set-up in position
_A:F#.15	Set-up position bit 0 ack.
_A:F#.16	Set-up position bit 1 ack.

Fig. 3-71: I/O of setup mode

Setup mode parameters

Parameter number	Designation
A-0-0001	Axis type
A-0-0009	Configuration idle mode / set up mode
A-0-0034	Setup positions - positive limits
A-0-0035	Setup positions - negative limits
A-0-0056	Setup position 0
A-0-0057	Setup position 1
A-0-0058	Setup position 2
A-0-0059	Setup position 3
A-0-0099	Setup speeds
S-0-0057	Position window
S-0-0108	Feedrate override
S-0-0124	Standstill window
S-0-0193	Positioning jerk
S-0-0260	Positioning acceleration
S-0-0393	Command value mode for modulo format

Fig. 3-72: Setup mode parameters

3.9 Idle

In this mode the following axis rotates at a specified speed, e.g., idle speed, independent of the master axis. Jogging inputs can be used to change this speed.

The "velocity command value" (S-0-0036) of the following axis is tracked in "idle speed 0" (A-0-0011) taking "idle acceleration" (A-0-0012) into account.

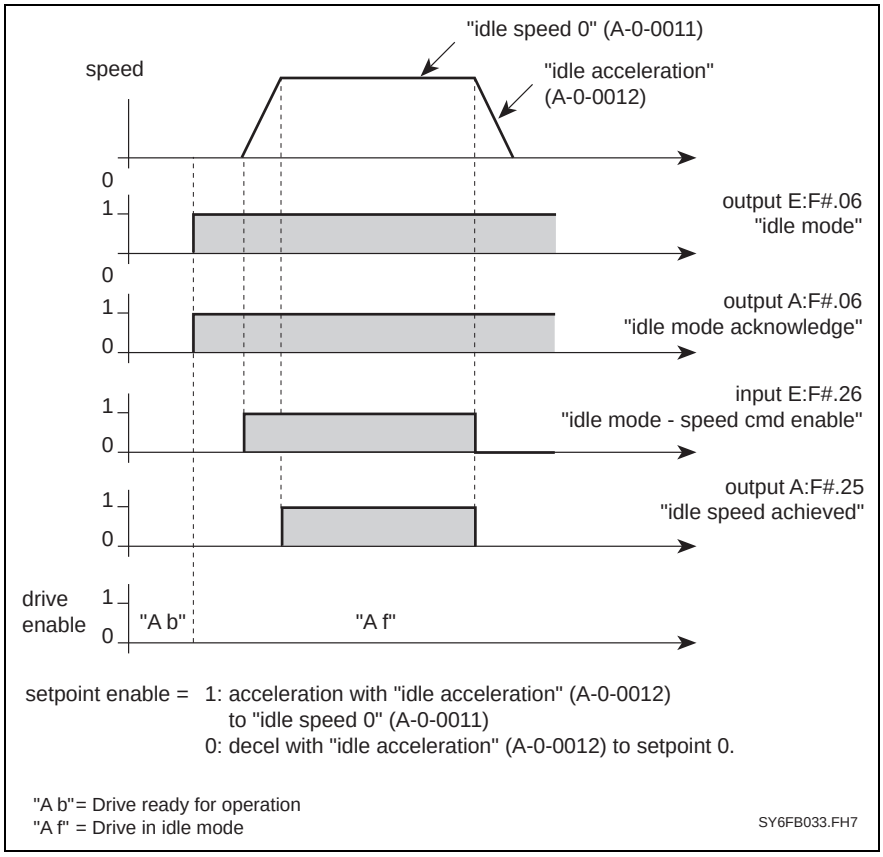


Fig. 3-73: Idle mode

This speed is retained, independent of the master axis, as long as idle mode is active. There is no coupling to the master axis.

Example **Turning an ink drum**

If a printing unit is shutdown, then it becomes necessary for an ink drum to turn at a certain speed, independent of the master axis movements, to prevent the ink from drying on the drum.

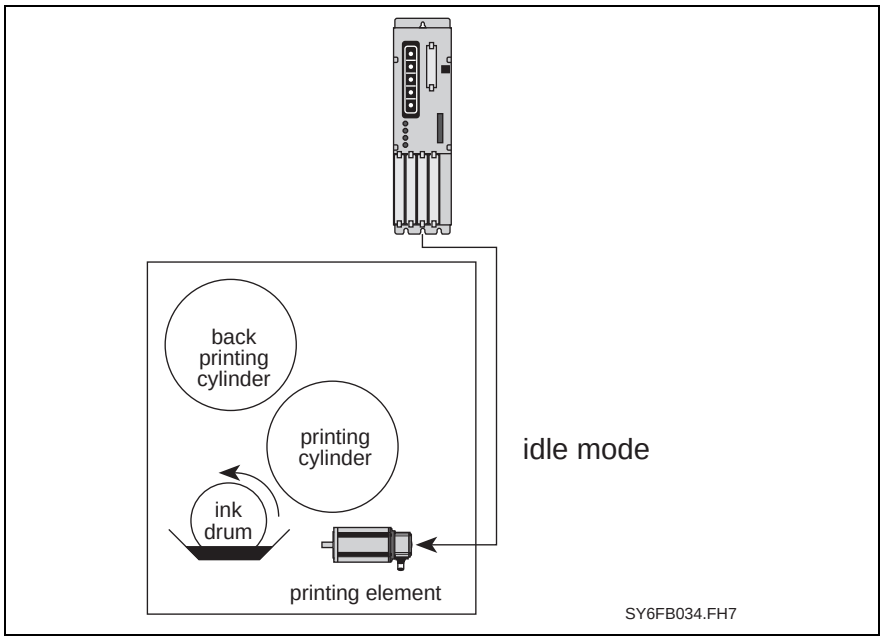


Fig. 3-74: Example: idle mode of a following axis - ink drum

Idle speeds

Four speeds can be preset for the idle mode. Each of the four idle speeds have their own limit values allocated to them.

The selection of an idle speed occurs via the binary inputs "select idle speed bit 0" (_E:F#.33) and "select idle speed bit 1" (_E:F#.34) .

Idle speed bit 1	**Idle speed bit 0**	**Speed**	**Limit value positive/negative**
0	0	Idle speed 0 A-0-0011	A-0-0023 / A-0-0024
0	1	Idle speed 1 A-0-0115	A-0-0109 / A-0-0110
1	0	Idle speed 2 A-0-0116	A-0-0111 / A-0-0112
1	1	Idle speed 3 A-0-0117	A-0-0113 / A-0-0114

Fig. 3-75: idle speeds

Note: "Idle acceleration" (A-0-0012) applies to each of the four idle speeds.

The active idle speed can be changed by:

- a jog input or
- writing into parameter "Idle speed *n*".

Binary I/Os of idle mode

Designation	Function
_E:F#.06	Idle mode
_E:F#.26	Idle mode - speed cmd enable
_E:F#.33	Select idle speed bit 0
_E:F#.34	Select idle speed bit 1
_A:F#.06	Idle mode acknowledge
_A:F#.25	Idle speed achieved
_A:F#.33	Idle speed bit 0 acknowledge
_A:F#.34	Idle speed bit 1 acknowledge

Fig. 3-76: Binary I/Os of idle mode

Idle mode parameters

Parameter number	Designation
A-0-0011	Idle speed
A-0-0012	Idle acceleration
A-0-0016	Idle speed increments
A-0-0023	Idle speed - positive limit
A-0-0024	Idle speed - negative limit
A-0-0109	Idle speed 1 - positive limit
A-0-0110	Idle speed 1 - negative limit
A-0-0111	Idle speed 2 - positive limit
A-0-0112	Idle speed 2 - negative limit
A-0-0113	Idle speed 3 - positive limit
A-0-0114	Idle speed 3 - negative limit
A-0-0115	Idle - speed 1
A-0-0116	Idle - speed 2
A-0-0117	Idle - speed 3

Fig. 3-77: Idle mode parameters

3.10 Free auxiliary modes (special modes)

Each following axis supports up to three auxiliary modes. Two of these modes are reserved for setup mode and idle mode. The 3. auxiliary mode is free programmable. To distinguish from the reserved modes the 3. auxiliary mode is also called a 'special mode'.

The 3. auxiliary mode is enabled with binary input "special mode" (_E:F#.23).

Basically each operating mode supported by a drive may be selected as a 'special mode'. Typical special modes are described below.

Relative setup mode

In 'relative setup mode' a following axis can be moved over a specified distance.

Activating relative setup mode

'Relative setup mode' is configured in parameter "special operation mode" (A-0-0070) and is enabled via binary input "special operation mode" (_E:F#.23).

When 'relative setup mode' is enabled, the actual position of the folllowing axis is copied as command value into parameter "target position" (S-0-0258). The axis remains in the actual position.

Specifying travel distance

The relative travel distance is set in parameter "setup mode relative - travel distance" (A-0-0135). When parameter A-0-0135 is changed, the new value is transmitted automatically to the drive.

- Transmission of a new travel distance is started immediately, if 'relative setup mode' is enabled.
- If 'realtive setup mode' is not active, transmission starts when special operating mode is enabled (_E:F#.23).

Input "relative position command lock" (_E:F#.27) works like a start siganl: after a positive edge at this input the axis starts moving over the programmed distance.

After reaching a new position, output "setup in position" (_A:F#.14) is set.

Setup speed

New target positions are approached with "positioning speed" (S-0-0259). Depending on the configuration of both setup modes, it applies to the setting of the effective positioning speed:

Special mode 'relative setup mode'	Auxiliary mode 'setup mode' (absolute)	Effective setup speed
configured	not configured	The setup speed for 'relative setup' is set manually with the commissioning program SynTop or via communication in parameter "positioning speed" (S-0-0259).
configured	not configured	Parameter S-0-0259 is also used in 'absolute setup mode'. Upon activation of this operating mode, the "positioning speed" is overwritten with "setup speed" (A-0-0099). The positioning speed thus always equals the previously last active setup speed in 'absolute setup mode'.

Fig. 3-78: Effective setup speed

Note: If 'Absolute setup mode' is configured, then parameter S-0-0259 cannot be changed either manually or via parameter transmission.

Binary I/Os of the 'relative setup mode'

The following I/Os are available:

Designation	Function
_E:F#.23	Special operation mode
_E:F#.27	Relative position command lock
_A:F#.23	Special operation mode acknowledge

Fig. 3-79: I/O of 'relative setup mode '

'Relative setup mode' parameters

Parameter number	Designation
A-0-0001	Axis type
A-0-0070	Special operation mode
A-0-0099	Setup speeds
A-0-0135	Setup mode relative - travel distance
S-0-0057	Position window
S-0-0108	Feedrate override
S-0-0124	Standstill window
S-0-0193	Positioning jerk
S-0-0260	Positioning acceleration
S-0-0393	Command value mode for modulo format

Fig. 3-80: 'Relative setup mode' parameters

Master-Slave mode

Functional Principle

The master-slave mode is suitable for mechanically coupled axes. *One* master drive generates the torque command for *one* or *several* slave drives. For the master drive, any operating mode is permissible. For a slave drive 'torque control' must be selected as special operation mode.

The torque command is transmitted as an analogue signal. The command value is assigned to an analogue output of the master drive and is received by the slave via the fast analogue input (channel 1) of an analogue interface.

Note: Master-slave mode requires drive firmware version ELS-05VRS or a higher version.

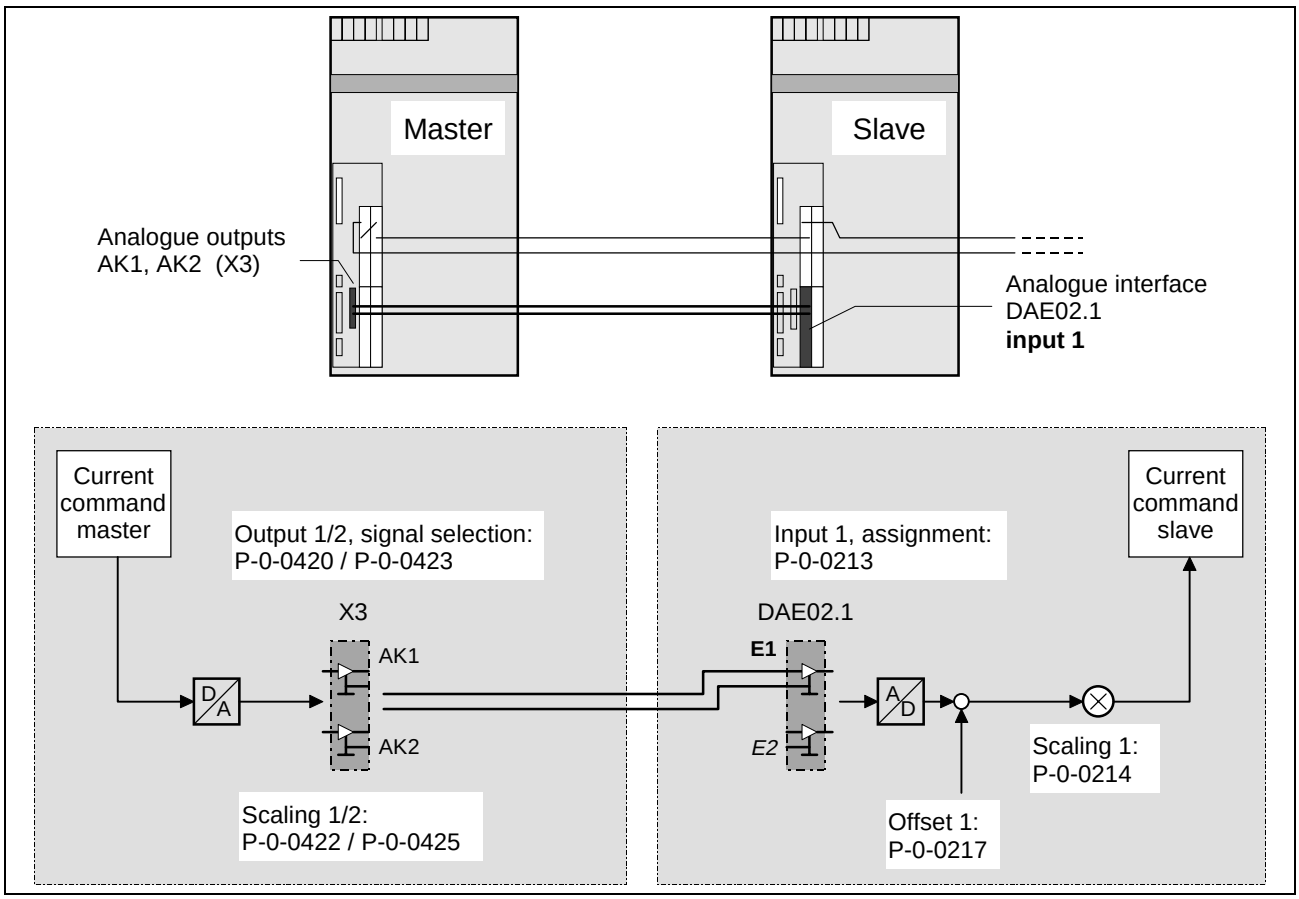


Fig. 3-81: Functional principle: master-slave mode

Settings for the master:

- The analog command value is output either via channel 1 or channel 2. Therefore, in parameter "Analogue output, signal selection" the torque/force command is selected as an output signal:

  Channel 1: P-0-0420 = S-0-0080

  Channel 2: P-0-0423 = S-0-0080

- The scaling of the effective current is set with parameter P-0-0422 (output channel 1) resp. P-0-0425 (output channel 2).

Settings for the slave:

- With parameter "special operation mode" torque-/force control is selected:

  A-0-0070 = 0x0001

- The analogue torque command value is read via channel 1 of a DAE2.1.

  Channel 1: P-0-0213 = S-0-0080

- The scaling of the analogue command value is defined with parameter P-0-0214:

  100 * S-0-0110 / S-0-0111 = Torque distribution 1:1

  S-0-0110: amplifier peak current

  S-0-0111: motor current at standstill

The special operation mode "torque-/force control" is enabled with the binary input "special operation mode" (_E:F#.23).

Binary I/O for master-slave mode

Designation	Function
_E:F#.23	Special operation mode
_A:F#.23	Special operation mode acknowledge

Fig. 3-82: Binary I/O for Master-Slave Mode

Parameters for master-slave mode

In the following table all parameters relevant for master-slave mode are listed.

Parameter number	Designation
A-0-0070	Special operation mode
P-0-0213	Analogue input-1, assignment
P-0-0214	Analogue input-1, scaling per 10V full scale
P-0-0217	Analogue input-1, offset
P-0-0420	Analogue output-1, signal selection
P-0-0423	Analogue output-2, signal selection
P-0-0422	Analogue output-1, scaling per 10V
P-0-0425	Analogue output-2, scaling per 10V

Fig. 3-83: Parameters for master-slave mode

3.11 Using I/Os to control the following axis

Setting up the operating mode

After power is switched on, an input can be used to set one of the following operating modes for each drive

- setup
- idle
- synchronization

This simultaneously

- selects the operating mode and
- actuates drive enable.

A corresponding output acknowledges that this setting has been made:

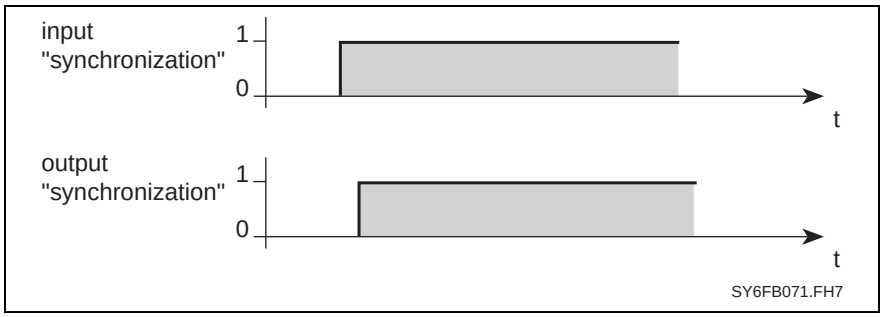


Fig. 3-84: Switching synchronization mode on

Changing operating modes

There are two ways to change operating mode:

- drive enable interrupt or
- maintaining drive enable.

If drive enable is to be interrupted when the operating mode is changed, then the new operating mode may not be set until the acknowledgement of the former operating mode is cancelled (non-overlapping change).

Example former mode: setup
new mode: synchronization

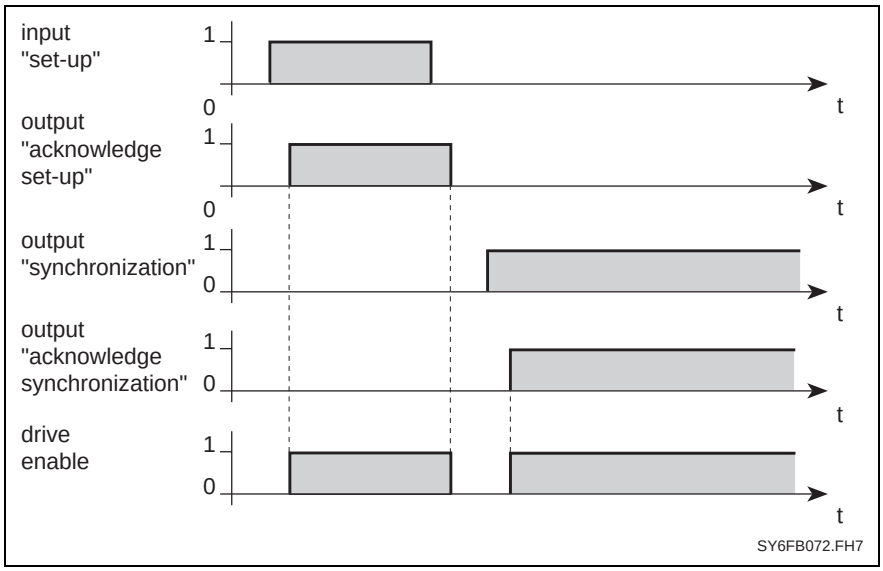


Fig. 3-85: Switching from setup to synchronization with drive enable interrupt

If drive enable is to be maintained when the operating mode is switched, then it is necessary to first set the new mode before the former mode is cancelled (overlapping change).

Cancelling the input of the old operating mode executes the change.

Example former mode: setup
new mode: synchronization

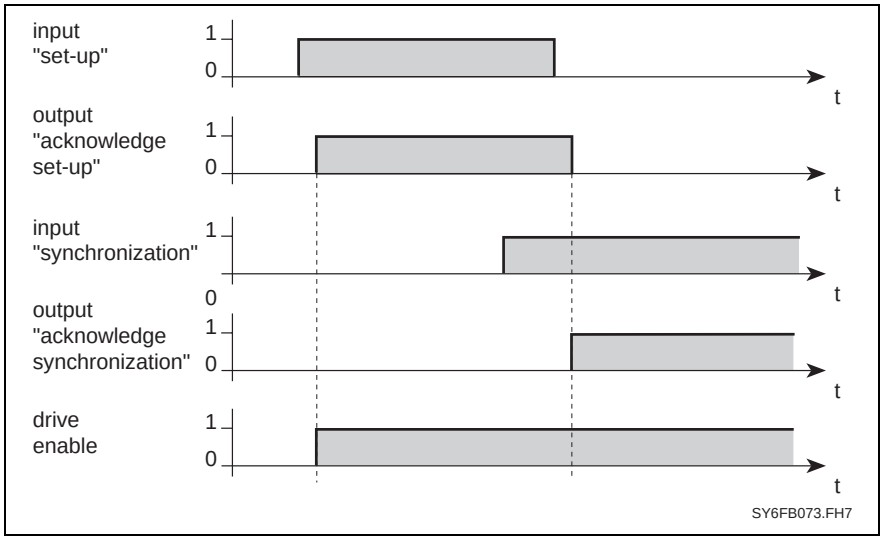


Fig. 3-86: Switching from setup to synchronization without drive enable interrupt

Referencing

If the following axis is equipped with an absolute measuring system, option, then the absolute position is already available when the machine is switched on. Referencing is not necessary. With incremental encoders, however, referencing is necessary to determine the absolute position of the drive.

If referencing is selected, then the drive will automatically proceed to the reference marker which is used to determine the absolute position.

Once the drive has completed referencing, it sends the appropriate message.

Example **Printing cylinder with incremental encoder**

If a printing cylinder is equipped with an incremental encoder, then referencing is needed to determine the absolute positon of the axis.

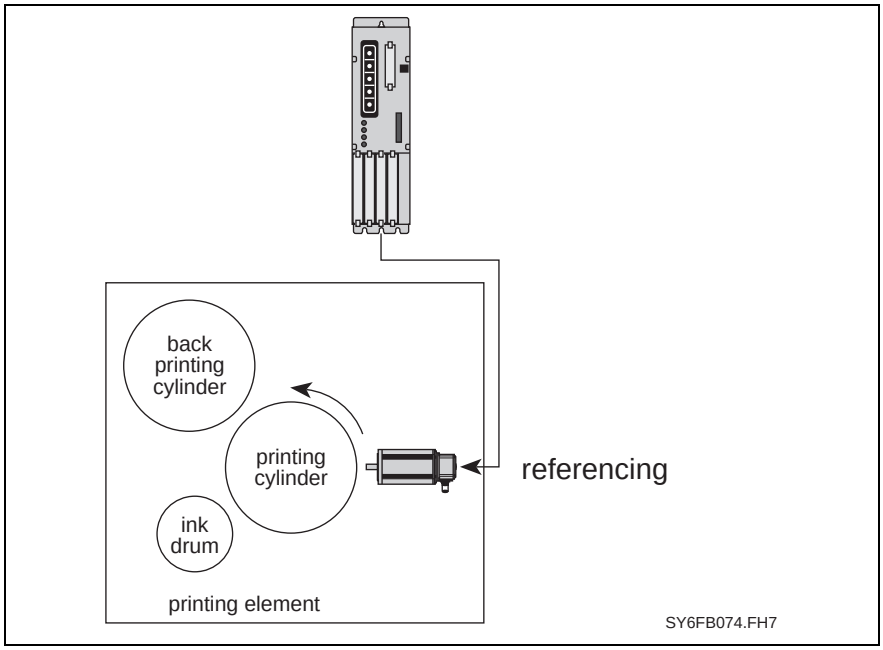


Fig. 3-87: Example: referencing a following axis (printing cylinder)

Drive enable (idle or setup) must be set for referencing. In other words, an operating mode has been selected and acknowledged.

An impulse must be applied to the referencing input so that referencing can be performed. This impulse is cancelled as soon as referencing is acknowledged.

Example **Referencing process with idle mode (without speed command enable)**

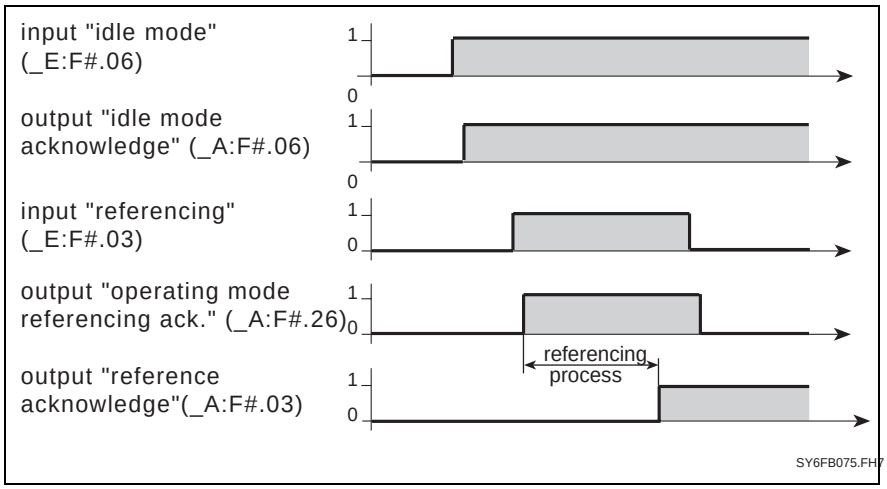


Fig. 3-88: The path of the signal during the referencing process

Drive halt

Using the drive halt function, an axis can be brought to standstill with both defined acceleration and jerk.

The function is activated by setting the binary input "Drive halt" (_E:F#.22). The drive brakes position-controlled with "Bipolar acceleration limit value" (S-0-0138) and "Jerk bipolar" (S-0-0349) to standstill and remains standing in position control.

The drive halt function can be used in operating, idle and setup modes.

Example Rapid stop in idle mode

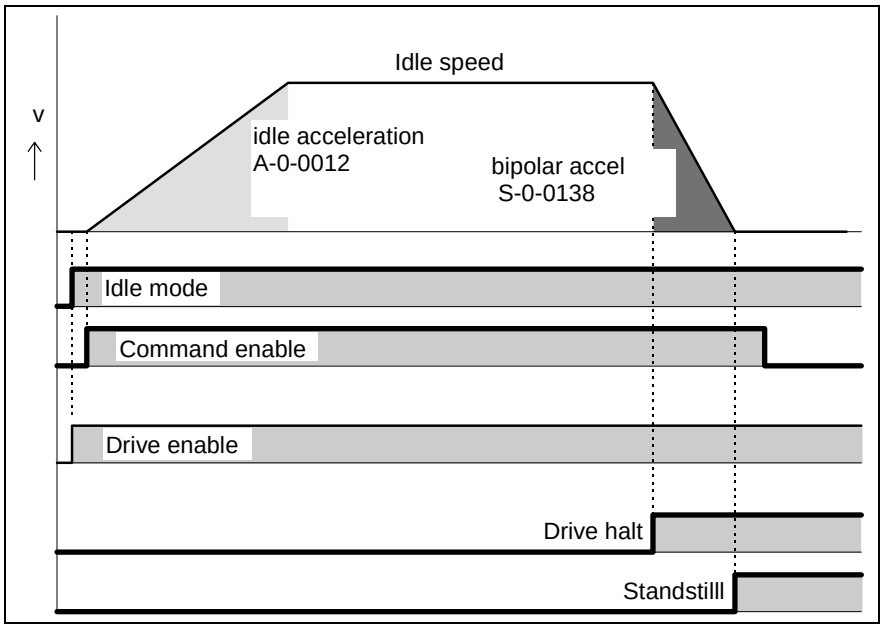


Fig. 3-89: Application example for the drive halt function

Binary I/Os of the following axis

The following inputs are available on the CLC for each drive:

Designation	Function
_E:F#.01	--
_E:F#.02	--
_E:F#.03	Referencing
_E:F#.04	Set-up mode
_E:F#.05	Synchronization mode
_E:F#.06	Idle mode
_E:F#.07	--
_E:F#.08	Preset position offset
_E:F#.09	Continuous manual operation
_E:F#.10	Manual operation grid
_E:F#.11	Manual operation speed set
_E:F#.12	Jog -
_E:F#.13	Jog +
_E:F#.14	Clear error
_E:F#.15	Select set up position bit 0
_E:F#.16	Select set up position bit 1
_E:F#.17	--
_E:F#.18	Process controller ON
_E:F#.19	Process controller preset
_E:F#.20	Process controller pause
_E:F#.21	Best possible shutdown if drive enable removed
_E:F#.22	Halt drive
_E:F#.23	Special operation mode
_E:F#.24	Torque reduced
_E:F#.25	Set absolute dimension
_E:F#.26	Idle mode - speed command value enable
_E:F#.27	Relative position command lock
_E:F#.28	--
_E:F#.29	--
_E:F#.30	Select cam table 2
...	
_E:F#.33	Select idle speed bit 0
_E:F#.34	Select idle speed bit 1
_E:F#.35	Process controller - setpoint lock
_E:F#.36	Process controller preset 2
_E:F#.37	Process controller - pause diameter calculation
_E:F#.38	Process controller - immediate diameter calculation
_E:F#.41	Synchronization mode - direction reversing

Fig. 3-90: Inputs of the following axis

The following outputs are on the CLC for each existing drive.

Designation	Function
_A:F#.01	Ready for powering up
_A:F#.02	Drive ready to operate
_A:F#.03	Reference acknowledge
_A:F#.04	Set-up mode acknowledge
_A:F#.05	Sync. Mode acknowledge
_A:F#.06	Idle mode acknowledge
_A:F#.07	Continuous manual operation ack.
_A:F#.08	Manual grid operation ack.
_A:F#.09	Warning
_A:F#.10	Error
_A:F#.11	Configured ELS master command valid
_A:F#.12	Position offset preset ack.
_A:F#.13	Synchronization ramp up achieved
_A:F#.14	Set-up in position
_A:F#.15	Set up position bit 0 ack.
_A:F#.16	Set up position bit 1 ack.
_A:F#.17	Standstill
_A:F#.18	Process controller ON ack.
_A:F#.19	Process controller preset ack.
_A:F#.20	Process variable in process window
_A:F#.21	Min. process variable exceeded
_A:F#.22	Max. process variable exceeded
_A:F#.23	Special operation mode acknowledge
_A:F#.24	Torque reduced acknowledge
_A:F#.25	Idle speed achieved
_A:F#.26	Operating mode referencing ack.
_A:F#.27	Winding control engaged
_A:F#.28	Negative jogging limit exceeded
_A:F#.29	Positive jogging limit exceeded
_A:F#.30	Cam table 2 active
_A:F#.31	In synchronization window
_A:F#.32	90 % Load
_A:F#.33	Idle speed bit 0 acknowledge
_A:F#.34	Idle speed bit 1 acknowledge
_A:F#.35	Process controller - setpoint lock acknowledge
_A:F#.36	Process controller preset 2 acknowledge
_A:F#.37	Register control - mark loss
_A:F#.38	Process controller - act. diameter > reference diameter
_A:F#.39	Process controller - min. reel diameter exceeded
_A:F#.40	Process controller - max. reel diameter exceeded
_A:F#.41	Acknowledge synchronization mode - direction reversing

Fig. 3-91: Outputs of the following axis

4 Internal and external I/O logic

4.1 General information

The I/O logic on the CLC offers the option of linking external binary control signals with control signals of the drive and the CLC (e.g., master axis). The functions include negation, and/or links as well as the use of markers.

The coupling of these external inputs/outputs can be either in parallel or in serial form. With parallel coupling, the additional difference is made between 24 volt switching signals and data transmission via a dual port ram (e.g., ISA-Bus) (CLC-P only).

The I/O logic orders the external I/Os by means of an allocation list of internal I/Os. This allocation list is loaded when the CLC is parametrized.

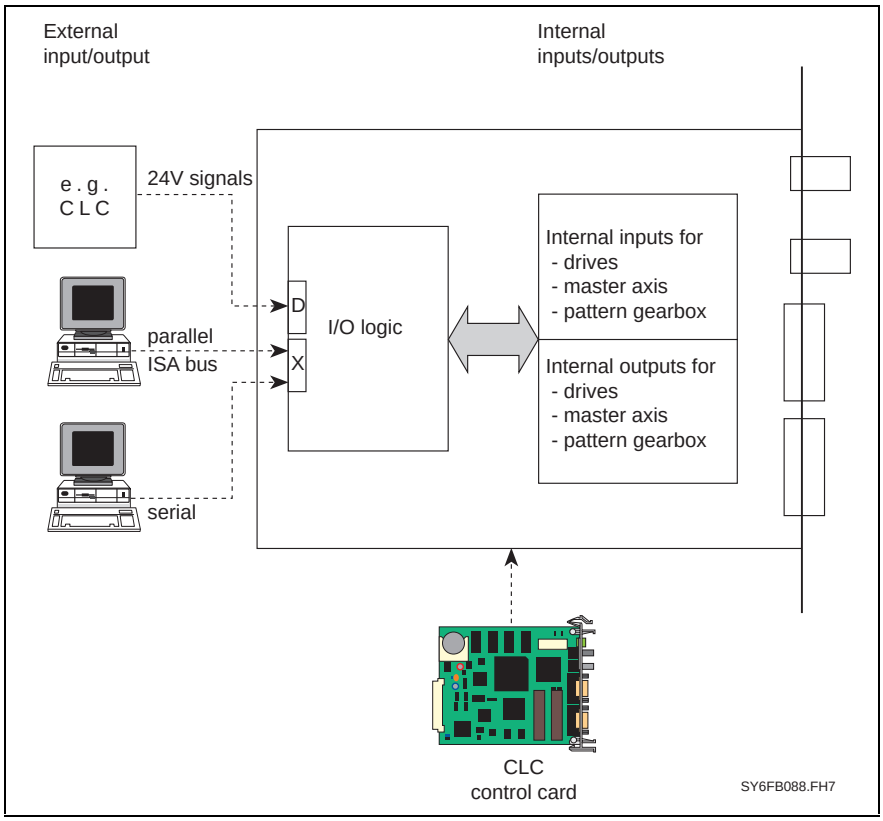


Fig. 4-1: CLC I/O logic

The I/O logic makes a memory capacity of 20,000 bytes available.

Given an average storage requirement of 14 bytes per command, this equals approximatey 1430 commands.

4.2 External I/O connection options

The external I/O connections can take one of the following forms:

- binary 24V - signals (e.g., DEA)
- dual port RAM (e.g., ISA bus)
- serial transmission (e.g., INTERBUS-S/Profibus)

External I/O coupling via DEA cards

The CLC control can be instituted via 24 volt signals of the DEA.

The external I/Os, in this case, are depicted on the DEA (or multiple DEAs):

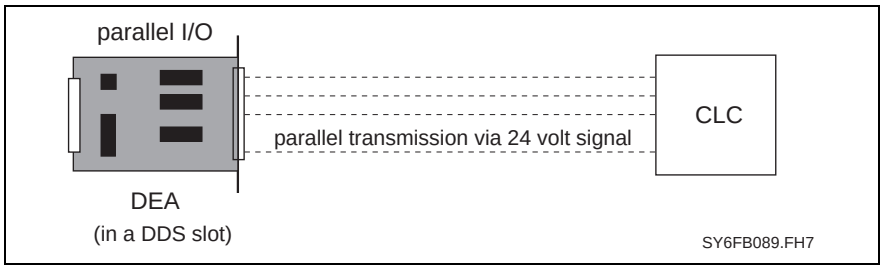


Fig. 4-2: I/O via binary 24V signals

The signals applied to this I/O are transmitted via the SERCOS ring to and from the CLC if a DEA4 is used.

With the use of DEA28, DEA29 and DEA30, transmission is via a unit internal bus.

Coupling the external I/O via a dual port RAM

The CLC can also implement a dual port RAM of the CLC-P for control.

In this case, the external I/Os are depicted at a specific storage address of the dual port RAM:

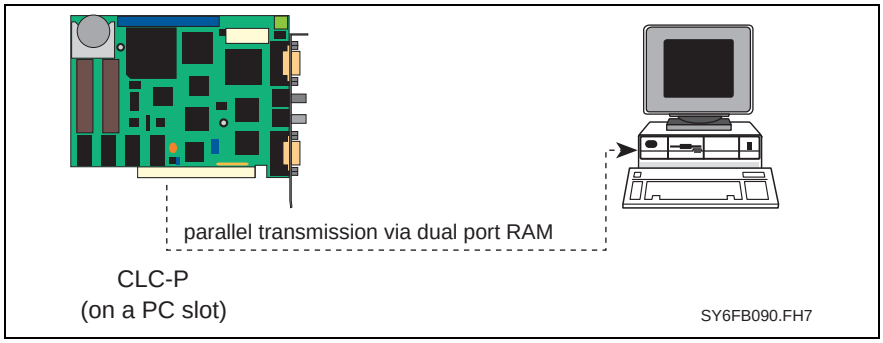


Fig. 4-3: I/O via a dual port RAM

This dual port ram transmission is described in Appendix B, "Interfaces".

External I/O coupling via serial transmission

The CLC can be controlled via a serial transmission.

In this case, the external I/Os are depicted on a serial transmission protocol.

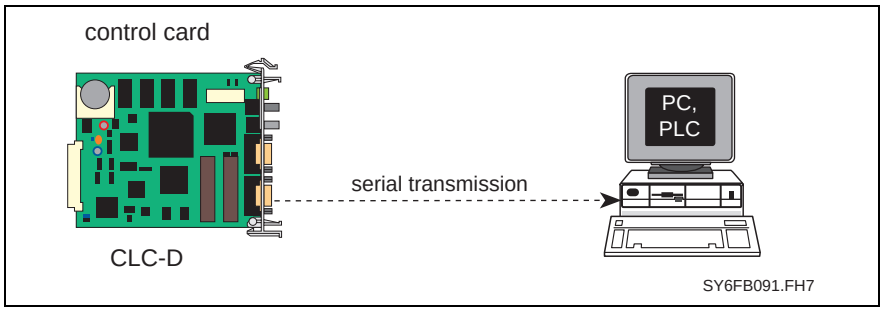


Fig. 4-4: I/O via serial transmission

A detailed description of this serial transmission can be found in Appendix B, "Interfaces".

I/O logic summary

The I/O logic can be used to freely program binary inputs and outputs (I/Os). The following illustration demonstrates possible access modes of various I/Os.

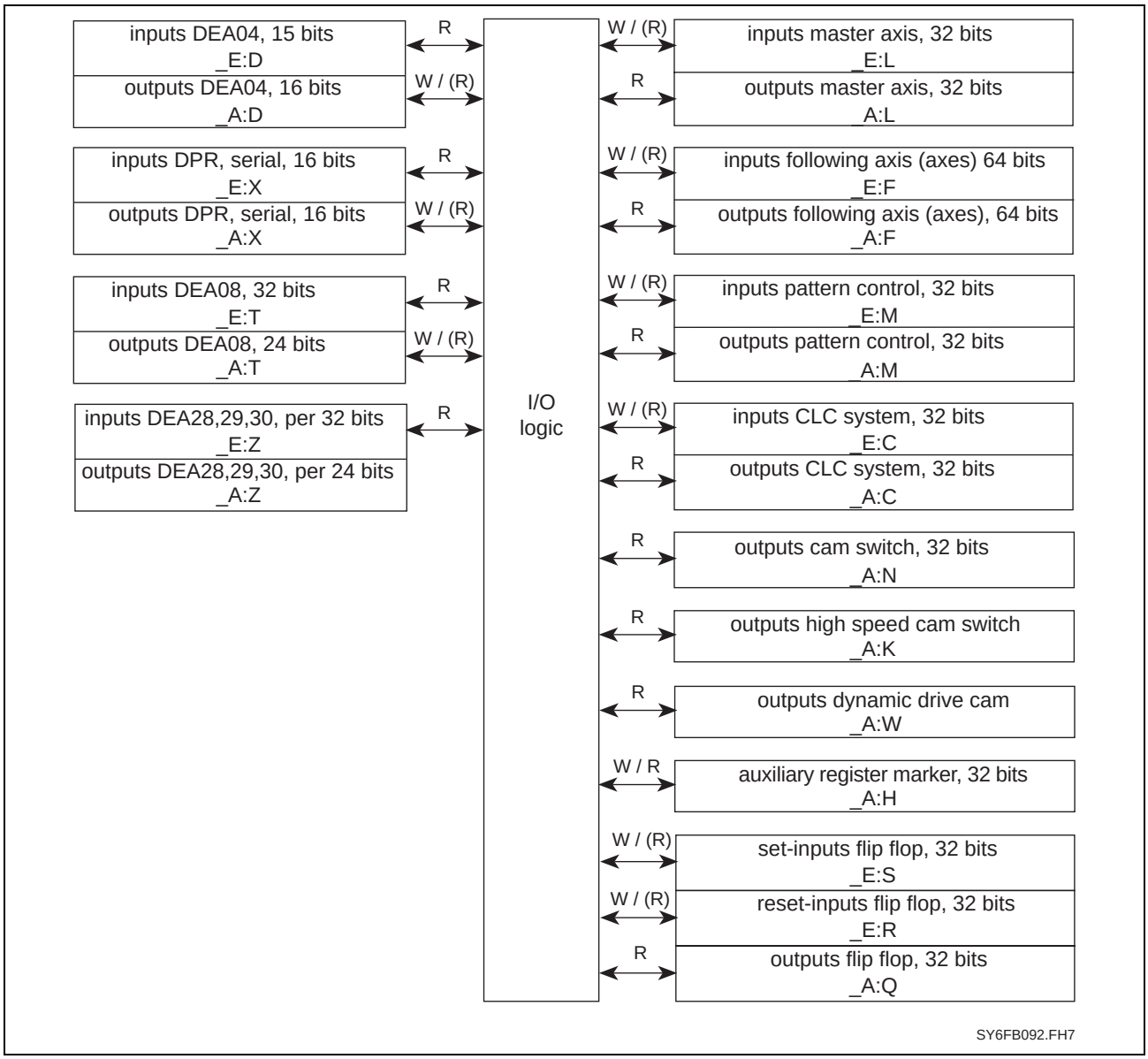


Fig. 4-5: Various ways to access I/O units

4.3 Available external I/Os

The different I/O units (I/O cards, DPRAM addresses, serial protocols) have up to 32 free programmable inputs and a maximum of 24 outputs.

I/Os of the DEA cards in the drives

The following DEA cards can be used:

- DEA04.x
- DEA08.x (drive firmware version 05VRS)

E/A card DEA04.x

The DEA04.x card has 15 inputs and 16 outputs.

Each drive which is fitted with a DEA04.x card is assigned to the following I/Os on the CLC:

Designation	Function
_E:D#.01	Freely definable input
_E:D#.02	Freely definable input
...	...
_E:D#.15	Freely definable input
_A:D#.01	Freely definable output
_A:D#.02	Freely definable output
...	...
_A:D#.16	Freely definable output (with CLC ready to operate watchdog function, see section: System outputs)

Fig. 4-6: I/Os of the DEA cards in the drives

The designation _A:D#.01 stands for a DEA04.x in the drive with address # (# = 1 ... 40).

Example Output number 5 of DEA04.x in the drive with address 3 is designated: **_A:D03.05**.

E/A card DEA08.x

The DEA08.x card has 32 inputs and 24 outputs.

Each drive which is fitted with a DEA08.x card is assigned to the following I/Os on the CLC:

Designation	Function
_E:T#.01	Freely definable input
_E:T#.02	Freely definable input
...	...
_E:T#.32	Freely definable input
_A:T#.01	Freely definable output
_A:T#.02	Freely definable output
...	...
_A:T#.24	Freely definable output

Fig. 4-7: I/Os of the DEA08 cards in the drives

The designation _A:T#.01 stands for a DEA08.x in the drive with address # (# = 1 ... 40).

Example Output number 11 of DEA08.x in the drive with address 3 is designated: **_A:T03.11**.

I/Os of the DEA cards on the CLC

DEA28.x, DEA29.x and DEA30.x are plugged onto the CLC.

DEA28.x, DEA29.x and DEA30.x have 32 inputs and 24 outputs each.

Designation	Function
_E:Z01.01	Freely definable input (DEA28)
_E:Z01.02	Freely definable input (DEA28)
...	...
_E:Z01.32	Freely definable input (DEA28)
_E:Z02.01	Freely definable input (DEA29)
_E:Z02.02	Freely definable input (DEA29)
...	...
_E:Z02.32	Freely definable input (DEA29)
_E:Z03.01	Freely definable input (DEA30)
_E:Z03.02	Freely definable input (DEA30)
...	...
_E:Z03.32	Freely definable input (DEA30)
_A:Z01.01	Freely definable output (DEA28)
_A:Z01.02	Freely definable output (DEA28)
...	...
_A:Z01.24	Freely definable output (DEA28)
_A:Z02.01	Freely definable output (DEA29)
_A:Z02.02	Freely definable output (DEA29)
...	...
_A:Z02.24	Freely definable output (DEA29)
_A:Z03.01	Freely definable output (DEA30)
_A:Z03.02	Freely definable output (DEA30)
...	...
_A:Z03.24	Freely definable output (DEA30)

Fig. 4-8: I/Os of the DEA cards

I/Os on the dual port RAM of the CLC-P

The I/Os are organized by word on the dual port RAM of the CLC-P, i.e., 16 bits. Ninety-nine words each are compiled into two storage ranges for binary inputs or outputs.

Designation	Function
_E:X#.01	Freely definable input
_E:X#.02	Freely definable input
...	...
_E:X#.16	Freely definable input
_A:X#.01	Freely definable output
_A:X#.02	Freely definable output
...	...
_A:X#.16	Freely definable output

Fig. 4-9: I/Os in the DPRAM

The designation 'X#' stands for one word in the dual port RAM with address offset # (# = 1...99).

Example: Binary outputs in DPRAM of CLC-P:

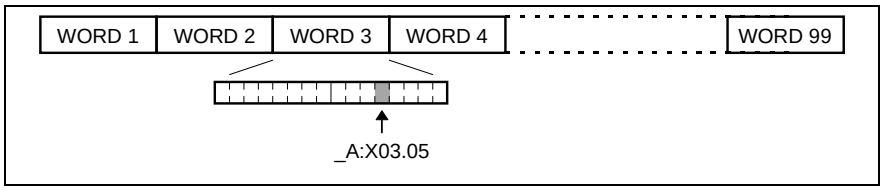


Fig. 4-10: Binary outputs in the DPRAM of CLC-P

Output number 5 in word with address offset 3 is designated: _**A:X03.05**.

Note: I/Os addressed in the I/O logic with 'X' are automatically read out of or written into the DPRAM by the CLC-P.

I/Os in serial protocols

The I/Os in serial protocols are organized by word, i.e., 16 bits.

If a CLC-D is used, then the I/Os labelled with 'X' on the serial interface are available, if a serial interface has been selected in parameter C-0-0033.

Designation	Function
_E:X#.01	Freely definable input
_E:X#.02	Freely definable input
...	...
_E:X#.16	Freely definable input
_A:X#.01	Freely definable output
_A:X#.02	Freely definable output
...	...
_A:X#.16	Freely definable output

Fig. 4-11: I/Os in serial protocols

Designation 'X#' stands for a word in the data field with address offset # (# = 1...32).

Note: A maximum of 32 words can be configured in all serial protocols in two data fields for binary I/Os. This means that a maximum of 512 inputs and outputs each are available.

Example Data fields for binary outputs with serial transmission:

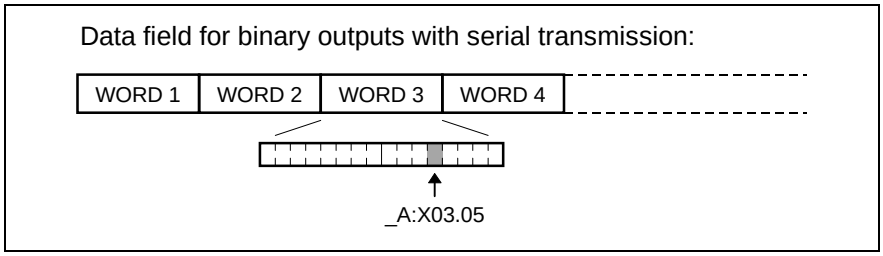


Fig. 4-12: Data field for binary outputs with serial transmission

Output number 5 in the third word of the data field is desginated: **_A:X03.05**.

I/O configuration with ARCNET and Siemens S5 coupling 3964R

With ARCNET and 3964R, binary I/Os can be transmitted either via a data block (DB99) or the Indramat protocol expansion (see Appendix B, "Interfaces").

All inputs and outputs are hereby compiled into one data field each. The length of the data field is automatically fixed on the CLC using the programmed I/O logic. It applies that:

- the highest word address for binary inputs specifies data field length for write access and
- the highest word address for binary outputs specifies the data field length for read access.

Note: If there are gaps in the addresses, then unused words are included in the configuration.

Example: In the I/O logic, data words 1 (_E:X1.*nn*), 2 (_E:X2.*nn*) and 5 (_E:X5.*nn*) are used for binary inputs. Data word 1 (_A:X1.*nn*) and 2 (_A:X2.*nn*) are used for outputs.

Configured data fields:

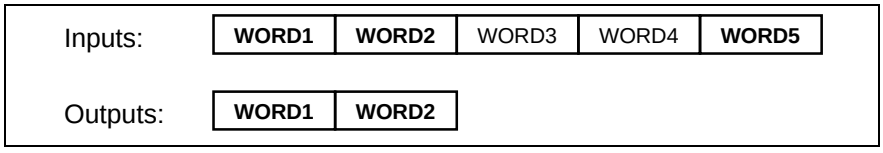


Fig. 4-13: Configured data fields

I/O configuration with field bus interfaces

With field busses (e.g., Profibus, INTERBUS-S) binary I/Os are transmitted as objects.

Between the objects and the I/O addresses in the I/O logic, there exists the following permanent allocation:

Objects for inputs	Word addresses	Objects for outputs	Word addresses
5FA0	_E:X01.*nn*	5F80	_A:X01.*nn*
5FA1	_E:X02.*nn*	5F81	_A:X02.*nn*
5FA2	_E:X03.*nn*	5F82	_A:X03.*nn*
. .	. .	. .	. .
5FBF	_E:X32.*nn*	5F9F	_A:X32.*nn*

Fig. 4-14: I/O addresses for field bus objects

4.4 Available internal I/Os

Each internal I/O unit has available to it a maximum of 32 inputs and 32 outputs. One internal I/O unit can, for example, represent the control signals of a drive.

Example The input designated

_E:F02.05

identifies the internal input (bit) number 4 of drive number 2.

The available internal I/Os are illustrated in the following subsection.

Note: All internal I/Os are HIGH active.

Master axis inputs

The following internal inputs exist on the CLC for the master axis:

Designation	Function
_E:L01.01	Virtual master E-Stop
_E:L01.02	VM speed command preset
_E:L01.03	--
_E:L01.04	--
_E:L01.05	Switch to virtual master
_E:L01.06	Virtual master enable
_E:L01.07	VM stop position 1 active
_E:L01.08	VM stop position 2 active
_E:L01.09	VM selection of speed cmd bit 0
_E:L01.10	VM selection of speed cmd bit 1
_E:L01.11	VM selection of speed cmd bit 2
_E:L01.12	Virtual master jog -
_E:L01.13	Virtual master jog +
_E:L01.14	VM jogging speed reduced
_E:L01.15	RM position monitoring enable
_E:L01.16	Real/Virt. Master - clear error
...	...
_E:L01.20	VM preset position
_E:L01.23	Real master - set absolute reference
_E:L01.24	Real master - set absolute measuring
_E:L01.25	ELS master command value additive - enable

Fig. 4-15: Master axis inputs

Virtual master speed command preset (_E:L01.02)

This input is only relevant if the speed command value for the virtual master is read out of a command value list (C-0-0054).

A speed command value which, for example, is changed via jogging inputs is cleared by setting the preset input to a preset value "Virtual master - speed command pre-setting" (C-0-0053).

Switch to virtual master (Change mode) (_E:L01.05)

This input is only relevant in change mode between virtual and real master axis. It is possible to switch between both master axes during operation.

_E:L01.05 = 0: switch to real master

_E:L01.05 = 1: switch to virtual master

(see "Change from real to virtual master axis", section. 2.8)

Virtual master stop position 1 / 2 active (_E:L01.07 / 08)

The virtual master is stopped at a programmed position.

(See "Positioning" in section. 2.3)

Virtual master select speed command value bit 0 / bit 1 / bit 2 (_E:L01.09 / 10 / 11)

These inputs are only relevant if the speed command value of the virtual master is read out of a command value list (C-0-0054).

Using the binary combination bit 0...2, one of a maximum of 8 programmed command values is selected.

(See "Basic function" in section. 2.3)

Virtual master jogging- / jogging + (_E:L01.12 / 13)

The speed of the virtual master is jogged with the use of these inputs.

(See "Jogging the master axis speed" in section. 11.2)

Virtual master jogging speed reduced (_E:L01.14)

The jogging function permits two jogging speeds:

_E:L01.14 = 0: jogging speed C-0-0043

_E:L01.14 = 1: jogging speed reduced C-0-0044

Real master position monitoring (_E:L01.15)

A monitoring function on the CLC checks whether the main shaft has moved once the plant was shutdown. This monitoring activitiy is standardly conducted only once after the system is switched back on.

By setting input _E:L01.15 it is possible to reactivate the monitoring function.

(See "Monitoring the master axis position" in section. 2.2)

Virtual master - preset position (_E:L01.20)

The value set as "virtual master - preset position" (C-0-0075) is assumed as the start position of the master axis.

This input is only effective if the virtual master has not been enabled ("Virtual master axis enable" = 0).

Real master - set absolute reference (_E:L01.23)

Upon activation of this input, the master axis position is re-initialized to the master encoder actual value.

master axis position = master encoder actual value x measuring gear + master encoder offset.

Note: The master axis position can abruptly change in this case.

Real master - set absolute measuring (_E:L01.24)

Upon activation of this input, the value set in parameter "real master - absolute reference" (C-0-0148) is accepted as the start position of the master axis.

Note: The master axis position can abruptly change in this case.

ELS master command value additive - enable (_E:L01.25)

If the input has been set, then the "ELS master - actual additive position value" (C-0-0160) is added to "ELS master command value additive" (C-0-0149) taking "ELS master command value offset speed" (C-0-0150) into account.

Master axis output

The following internal outputs for the master axis are on the CLC.

Designation	Function
_A:L01.01	Virtual master E-Stop
_A:L01.02	RM redundant encoder error
_A:L01.03	Virtual/real master error
_A:L01.04	--
_A:L01.05	Virtual master axis active
_A:L01.06	VM enable acknowledge
_A:L01.07	VM speed command value achieved
_A:L01.08	Real master moved
_A:L01.09	Real master positive direction
_A:L01.10	Virtual/real master standstill
_A:L01.11	VM speed switching signal 1
_A:L01.12	VM speed switching signal 2
_A:L01.13	VM speed switching signal 3
_A:L01.14	VM speed switching signal 4
_A:L01.15	VM speed switching signal 5
_A:L01.16	VM speed switching signal 6
_A:L01.17	VM speed switching signal 7
_A:L01.18	VM speed switching signal 8
_A:L01.19	Virtual master in position
_A:L01.20	VM preset position acknowledge
_A:L01.21	VM negative jogging limit exceeded
_A:L01.22	VM positive jogging limit exceeded
_A:L01.23	Real master - set absolute reference acknowledge
_A:L01.24	Real master - set absolute measuring acknowledge
_A:L01.25	ELS master command value additive achieved

Fig. 4-16: Master axis outputs

Virtual / real master error (_A:L01.03)

This output is a collective error message for the master axis. It is implemented in the following situations:

- The E-STOP of the virtual master was actuated (see also "virtual master acknowledge E-stop").
- The internal master axis position has become invalid as a new firmware version is being implemented.
- The position monitor of the real master has been triggered (see also "real master axis moved").
- The monitor of the redundant encoder has been triggered (see also "real master axis error redundant encoder").

Virtual master axis active (Change mode) (_A:L01.05)

Change mode permits a switching between the real and virtual master axes. This output displays which master is active.

_A:L01.05 = 0: real master axis active

_A:L01.05 = 1: virtual master axis active

(see "Change from real to virtual master axis", section. 2.8)

Real master positive rotational direction (_A:L01.09)

_A:L01.09 = 0: negative rotational direction

_A:L01.09 = 1: positive rotational direction

Virtual / real master standstill (_A:L01.10)

Virtual master: actual speed value equals zero

Real master: the actual speed value within the standstill window (C-0-0003).

Virtual master speed signal 1 ... 8 (_A:L01.11 ... 18)

These outputs are allocated to the eight speed switching points of the master axis.

(See "Speed operating points" section. 2.7)

Virtual master - in Position (_A:L01.19)

The speed of the virtual master axis is zero and the actual position of the virtual master is equal to the stop position selected via the binary inputs.

Real master - set absolute reference acknowledge (_A:L01.23)

Re-establishing the absolute reference of the real master axis is acknowledged with this output.

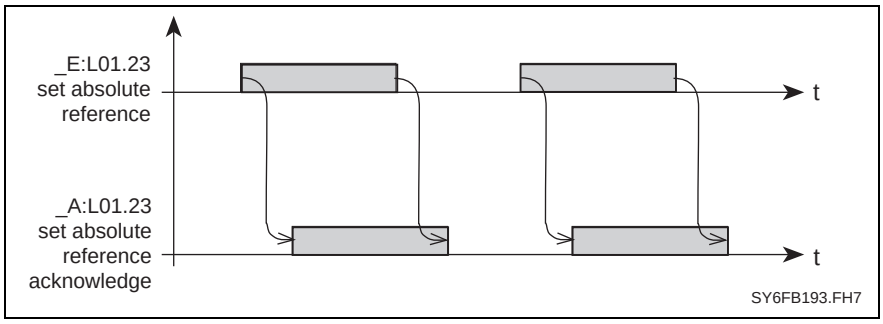


Fig. 4-17: Real master - set absolute reference acknowledge

Real master - set absolute measuring acknowledge (_A:L01.24)

This output indicates that the contents of the parameter "real master - absolute reference" (C-0-0148) is effective and is taken into account in parameter "ELS master - actual position value" (C-0-0066) and "ELS master - actual position value absolute format" (C-0-0146).

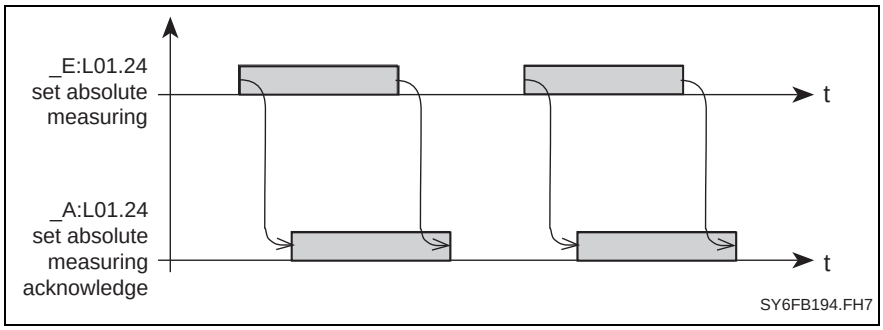


Fig. 4-18: Real master - set absolute measuring acknowledge

ELS master command value additive achieved (_A:L01.25)

This output indicates, that the current "ELS master - command value additive " has been achieved.

(see also chapter 2.4 "Additive master axis command value")

Outputs of the standard cam switch

The standard cam switch of the master axis makes up to 6 outputs (cams) available.

Designation	Function
_A:N01.01	cam switch bit 1
_A:N01.02	cam switch bit 2
_A:N01.03	cam switch bit 3
_A:N01.04	cam switch bit 4
_A:N01.05	cam switch bit 5
_A:N01.06	cam switch bit 6

Fig. 4-19: Outputs of the standard cam switch

High speed cams of the master axis

The standard high speed cam switch makes up to 32 outputs (cams) available.

Designation	Function
_A:K01.01	High speed cam switch 1
_A:K01.02	High speed cam switch 2
...	...
_A:K01.32	High speed cam switch 32

Fig. 4-20: Outputs of the high speed cam switch

Following axis inputs

For every drive there are the following inputs on the CLC.

Designation	Function
_E:F#.01	--
_E:F#.02	--
_E:F#.03	Referencing
_E:F#.04	Set-up mode
_E:F#.05	Synchronization mode
_E:F#.06	Idle mode
_E:F#.07	--
_E:F#.08	Preset position offset
_E:F#.09	Continuous manual operation
_E:F#.10	Manual operation grid
_E:F#.11	Manual operation speed set
_E:F#.12	Jog -
_E:F#.13	Jog +
_E:F#.14	Clear error
_E:F#.15	Select set up position bit 0
_E:F#.16	Select set up position bit 1
_E:F#.17	--
_E:F#.18	Process controller ON
_E:F#.19	Process controller preset 1
_E:F#.20	Process controller pause
_E:F#.21	Best possible shutdown if drive enable removed
_E:F#.22	Halt drive
_E:F#.23	Special operation mode
_E:F#.24	Torque reduced
_E:F#.25	--
_E:F#.26	Idle mode - speed command enable
_E:F#.27	Relative position command lock
_E:F#.28	--
_E:F#.29	--
_E:F#.30	Select cam table 2
...	
_E:F#.33	Select idle speed bit 0
_E:F#.34	Select idle speed bit 1
_E:F#.35	Process controller - setpoint lock
_E:F#.36	Process controller preset 2
_E:F#.37	Process controller - pause diameter calculation
_E:F#.38	Process controller - immediate diameter calculation
_E:F#.41	Synchronization mode - direction reversing

Fig. 4-21: Following axis inputs

Designation _E:F#.01 stands for the drive with address # (# = 1...40).

Example The input for the synchronization mode of the drive with address 3 is designated: _E:F03.05.

Referencing (_E:F#.03)

Function "Drive-guided referencing" is started. Precondition is that the drive enable must be set.

Note: This input is not used for "set absolute dimension" for axes with absolute encoder. Therefore parameter P-0-0012 is used.

(See "Using I/Os to control the following axes" section. 3.11)

Setup mode (_E:F#.04)

Setup mode is set in the drive and the drive enable signal set.

Synchronization mode (_E:F#.05)

Synchronization mode is set in the drive as per A-0-0003 and the drive enable signal set.

Idle mode (_E:F#.06)

Idle mode is set in the drive and the drive enable signal set. The speed command value is generated with zero.

Not until the "idle mode speed command enable" (_E:F#.26) is set can the axis be moved.

Position offset preset (_E:F#.08)

This input is only effective in angle synchronization mode. The value parametrized as "position command offset - preset value" (A-0-0002) is assumed in "position command offset" (A-0-0004).

Note: The preset is triggered with a positive edge at input _E:F#.08.

Continuous manual operation (_E:F#.09)

The jog function is enabled. As long as this input is not set, then inputs "jog+" and "jog -" are not evaluated.

Manual operation speed set (_E:F#.11)

The jog function permits two jogging speeds:

_E:F#.11 = 0: jog speed C-0-0043

_E:F#.11 = 1: jog speed reduced C-0-0044

(See "Operating principle of the jogging function" section. 11.1)

Jog - (_E:F#.12), jog + (_E:F#.13)

Operating variables can be altered via these inputs, e.g., angle offset, and gear fine adjustments.

The jog inputs are only effective if the mode is active and "Continuous manual operations" (_E:F#.09) has been set.

(See "Operating principle of the jogging function" section. 11.1)

Clear error (_E:F#.14)

This input is used to clear a drive error.

Given an error, the drive internal enable is reset. If another mode is waiting, then it will no longer be active. A renewed setting of previously active synchronization, setup or idle mode (with drive enable) requires a positive edge at one of the operating mode inputs.

"Clear error" must be applied until the output "error" (_A:F#.10) disappears.

Select setup position bit 0 / bit 1 (_E:F#.15, _E:F#.16)

These inputs are only effective in setup mode.

They permit a switch between four parametrizable setup positions.

Bit 1	Bit 0	Active target position
0	0	setup position 0
0	1	setup position 1
1	0	setup position 2
1	1	setup position 3

Fig. 4-22: Binary inputs "Select setup position bit 0 / bit 1"

(See "Setup mode" section. 3.2)

Process controller ON (_E:F#.18)

The configured process controller is activated. This can be either a tension control, a dancer control, a register control or a winding control.

Process controller preset 1 (_E:F#.19)

Depending on the configured process control function, a process variable can be written over with a preset value or it can be set to zero:

Process control function	How it works
Tension control	The control output is set to "process controller - preset 1 (fine adjustment)" (A-0-0075).
Dancer control	- no preset function -
Direct register control	- no preset function -
Indirect register control	The control output is set to zero.
Winding control without sensors	The diameter is set to start value (A-0-0078).
Control with a dancer	- no preset function -

Fig. 4-23: Process control preset function

The preset input is only effective if the process control is switched off ("process control ON" = 0).

Process control pause (_E:F#.20)

Depending on the configured process control function, this input functions as follows:

Process control function	How it works
Tension control	- no function -
Dancer control	The controller output is frozen as long as "Process controller pause" is pending.
Direct register control	- no function -
Indirect register control	The controller output is frozen as long as "Process controller pause" is pending.
Winding control without sensors	The current reel diameter and current torque at the winding axis are frozen as long as "Process controller pause" is pending. The winding axis is halted while the referenced axis continues to run.
Winding control with a dancer	The output of the dancer controller is frozen as long as "Process controller pause" is pending.

Fig. 4-24: Process controller pause

Best possible shutdown if drive enable removed (_E:F#.21)

This input can be used to activate best possible shutdown (see P-0-0119) in the event that the operating mode is removed.

Halt drive (_E:F#.22)

The drive brakes with "Bipolar acceleration - limit value" (S-0-0138) to zero velocity and remains in position control.

This input is effective in every mode.

Special operation mode (_E:F#.23)

This input activates the special mode set in "special operation mode" (A-0-0070).

Torque reduced (_E:F#.24)

= 1: Reduces the torque S-0-0092 of the drive to the value programmed in A-0-0037.

= 0: Sets the torque S-0-0092 of the drive to the value programmed in A-0-0038.

Idle mode command value enable (_E:F#.26)

This input is only effective in idle mode.

The idle speed set is assumed in speed command value. As long as the command value enable is not applied the speed command value remains at zero.

Relative position command lock (_E:F#.27)

This input is only functional in "Relative setup" mode.

The (continued) positioning around the parametrized travel path is started with a positive edge.

Select cam table 2 (_E:F#.30)

= 1: This preselects "Cam shaft profile 2" (P-0-0092). If the master axis passes the "Cam shaft switch angle" (P-0-0094), then the switch in the drive to cam 2 is automatic.

= 0: This preselects "Cam shaft profile 1" (P-0-0072). If the master axis passes the "Cam shaft switch angle" (P-0-0094), then the switch in the drive to cam 2 is automatic.

(See "Electronic cam", "changing between cam profile 1 and 2", section. 3.5)

Select idle speed bit 0 / bit 1 (_E:F#.33, _E:F#.34)

These inputs are only effective in idle mode.

They permit the switching between four parametrizable idle speeds.

Bit 1	Bit 0	Active idle speed
0	0	idle speed 0
0	1	idle speed 1
1	0	idle speed 2
1	1	idle speed 3

Fig. 4-25: Binary inputs "select idle speed bit 0 / bit 1"

Process controller - setpoint lock (_E:F#.35)

This input function as follows, depending on the configured process controller function:

Process control function	How it works
Tension control	The current actual tension value is assumed as a command value for the tension controller.
Dancer control	The current dancer position is assumed as a command value for the dancer controller.
Register control	The current actual position value at the measured axis is assumed as a position command value for the register controller.
Winding control without sensors	- no function -
Winding control with a dancer	The current dancer position is assumed as a command value for the dancer controller.

Fig. 4-26: Process control: command lock

Process controller preset 2 (_E:F#.36)

This input is only function in register control. It can be used to clear the sample memory.

Process controller - pause diameter calculation (_E:F#.37)

This input is only relevant in connection with process controller function "winding controller with dancer".

The current diameter is frozen once this input is activated.

Process controller - immediate diameter calculation (_E:F#.38)

The cyclical diameter calculation takes place with active input "process controller - immediate diameter calculation" (_E:F#.38) about 50 x per revolution, with inactive input about 1 x per revolution.

The calculated diameter is less precise with activated immediate diameter calculation, eccentricies in the angle falsify diameter calculations.

Synchronization mode - direction reversing (_E:F#.41)

The rotational direction of a following axis in terms of the master axis is defined in parameter "lead drive polarity" (P-0-0108). This pre-defined rotational direction can be inverted with input "synchronization mode - direction reversing".

This input is effective in all synchronization modes and also in special opearting mode , if this is used with as a synchronization mode.

It applies:

Input _E:F#.41	Rotational direction in synchronization mode
0	The rotational direction is defined by parameter "lead drive polarity" (P-0-0108).
1	The pre-defined rotational direction is inverted.

Fig. 4-27: Binary I/O: direction reversing

A change at input "direction reversing" is evaluated only if snychronization mode resp. speacial mode is not activated (_E:F#.05 = 0 or _E:F#.23 = 0).

Note: Operating mode synchronization may not be activated until after synchronization mode - direction reversing (_A:F#.41) has been acknowledged.

Note: If a register controller is parametrized with "variable actual position value at the load" in parameter "process control control word 1" (A-0-0025) then the direction of a measuring axis may not be changed.

Speed synchronization

Upon activation of this input, the "velocity command value additive" (S-0-0037) is automatically inverted.

The "velocity command value additive" is the addition of:

- Speed offset (A-0-0031),
- Manipulated variables of the register controller (A-0-0093 or A-0-0094),
- Manipulated variables of the dancer controller (A-0-0137),
- Manipulated variables of the winder (A-0-0097).

Example:

_E:F#.41	**master axis velocity command value (C-0-0006)**	**speed offset (A-0-0031)**	**effective velocity command value in drive (S-0-0036 + S-0-0037)**
0	100 rpm	10 rpm	110 rpm
1	100 rpm	10 rpm	-110 rpm

Fig. 4-28: Direction reversing in speed synchronization

Phase synchronization and Electronic Cams

The "position command value additive" (S-0-0048) is not inverted.

The "position command value additive" is the addition of:

- Position command value additive target value (A-0-0004),
- Group command value additive 1 (A-0-0132),
- Group command value additive 2 (A-0-0155),
- Manipulated variable of the register controller (A-0-0093 or A-0-0094).

Example:

_E:F#.41	**master axis - master axis actual value (C-0-0066)**	**position command value additive target value (A-0-0004)**	**effective position command value in the drive (S-0-0047 + S-0-0048)**
0	100 degree	45 degree	145 degree
1	260 degree	45 degree	305 degree

Fig. 4-29: Direction reversing in phase synchronization

Note: An absolutely synchronized axis re-synchronizes.

Following axis outputs

For each drive there are on the CLC, the following outputs.

Designation	Function
_A:F#.01	Ready for powering up
_A:F#.02	Drive ready to operate
_A:F#.03	Reference acknowledge
_A:F#.04	Set-up mode acknowledge
_A:F#.05	Sync. mode acknowledge
_A:F#.06	Idle mode acknowledge
_A:F#.07	Continuous manual operation ack.
_A:F#.08	Manual grid operation ack.
_A:F#.09	Warning
_A:F#.10	Error
_A:F#.11	Configured ELS master commands valid
_A:F#.12	Position offset preset ack.
_A:F#.13	Synchronization ramp up achieved
_A:F#.14	Set-up in position
_A:F#.15	Set up position bit 0 ack.
_A:F#.16	Set up position bit 1 ack.
_A:F#.17	Standstill
_A:F#.18	Process controller ON ack.
_A:F#.19	Process controller preset ack.
_A:F#.20	Process variable in process window
_A:F#.21	Minimum process variable exceeded
_A:F#.22	Maximum process variable exceeded
_A:F#.23	Special operation mode acknowledge
_A:F#.24	Torque reduced acknowledge
_A:F#.25	Idle speed achieved
_A:F#.26	Operating mode referencing ack.
_A:F#.27	Winding control engaged
_A:F#.28	Negative jogging limit exceeded
_A:F#.29	Positive jogging limit exceeded
_A:F#.30	Cam table 2 active
_A:F#.31	In synchronization window
_A:F#.32	90 % Load
_A:F#.33	Idle speed bit 0 acknowledge
_A:F#.34	Idle speed bit 1 acknowledge
_A:F#.35	Process controller - setpoint lock acknowlegde
_A:F#.36	Process controller preset 2 acknowledge
_A:F#.37	Register control - mark loss
_A:F#.38	Process controller - act. diameter > refrence diameter
_A:F#.39	Process controller - min. reel diameter exceeded
_A:F#.40	Process controller - max. reel diameter exceeded
_A:F#.41	Acknowledge synchronization mode - direction reversing

Fig. 4-30: Following drive outputs

Designation _A:F#.01 stands for the drive with address # (# = 1...40).

Example The output for the acknowledgement of synchronization mode of the third drive in the ring is designated: **_A:F03.05**.

Ready for powering up (_A:F#.01)

The drive is ready to receive power.

Drive ready to operate (_A:F#.02)

Power is on. The drive is ready to receive the command value.

Reference acknowledge (_A:F#.03)

- Given an incremental linear scale or absolute single turn linear scale:
  the drive was referenced.
- Given an absolute linear scale:
  The reference position was established with "set absolute dimension".

Setup mode acknowledge (_A:F#.04)

The drive has switched to "setup" mode. The drive is in control.

Synchronization mode acknowledge (_A:F#.05)

The drive has switched to synchronization mode (A-0-0003). The drive is in control.

Idle mode acknolwedge (_A:F#.06)

The drive has switched to "idle" mode. The drive is in control.

Continuous manual operation acknowledge (_A:F#.07)

The inputs "jog +" and "jog -" have been released.

Configured ELS master commands valid (_A:F#.11)

This output is set, when the master commands received via the CLC link are valid (_A:C02.01...32).

Example: A drive in a CLC ring with link address 4 follows the master axis in CLC ring 12 and the ELS master command value additive from a CLC ring with address 15. The output is set, when valid data are received from link participants 12 and 15 (_A:C02.12 and _A:C02.15 are set).

Synchronization ramp up achieved (_A:F#.13)

This output is effective in modes "angle synchronization", "electronic cam" and "electronic pattern garbox". "Synchronization ramp up achieved" is set if the following axis has reached the position synchronous to the master axis.

(See "Establishing absolute synchronization", "position adjustments during synchronization", section. 3.7)

Setup in position (_A:F#.14)

This output is effective in "setup" mode. The drive has taken the preset target position in position control (setup position 0, 1, 2 or 3).

The message "in position" is set if the axis is in "Position window" (S-0-0057) and in "standstill window" (S-0-0124).

Acknowledge setup position bit 0 / bit 1 (_A:F#.15, _A:F#.16)

These outputs are used to acknowledge the output of the setup position.

See inputs "Select setup position bit 0 / bit 1" (_E:F#.15, _E:F#.16).

Standstill (_A:F#.17)

This output is set if the axis is in the "standstill window" (S-0-0124).

Process variable in process window (_A:F#.20)

In connection with the process control function "tension control", "register control" and "winding control" are monitored as to whether the operating variables are within the range set.

The meaning of this output depends on the set process control function and is depicted in the following table.

Process control function	"Process variable in process window" (_A:F#.20) = 1
Tension control	The tension control actual value is in the monitoring window that has been set with parameter "process variable window" (A-0-0061).
Dancer control	The current dancer position is in the monitoring window that has been set with parameter "process variable window" (A-0-0061).
Register control	In monitoring window (parameters A-0-0088 and A-0-0089) a measuring pulse of the register marker was detected ("Marker in window").
Winding control without sensors	The tension is within the range of the monitoring window that was set with parameter "Process variable window" (A-0-0061).
Winding control with a dancer	The current dancer position is in the monitoring window that has been set with parameter "process variable window" (A-0-0061).

Fig. 4-31: The definition of (_A:F#.20) as dependent on the process control function

Min. / Max. process variable exceeded (_A:F#.21 / 22)

In conjunction with process control function "tension control" and "register control" the operating variables are monitored for maintaining limit values. If the monitor is triggered, then the relevant output is set to ’1’.

The definition of both outputs as dependent on the set process control function is depicted in the following table.

Process control function	Min./max. process variable exceeded (_A:F#.21/_A:F#.22) = 1
Tension control	Min./max. permissible tension exceeded.
Dancer control	Min./max. permissible dancer position exceeded.
Register control	The variables of the register control are limited in a negative/position direction by the maximum permissible motional range (A-0-0106).
Winding control	*- no monitor implemented -*
Winding control with a dancer	Min./max. permissible dancer position exceeded.

Fig. 4-32: Definition of outputs (_A:F#.21 and _A:F#.22) as dependent on the process control function

Torque reduced acknowledged (_A:F#.24)

= 1: Torque has been successfully reduced to the value programmed in A-0-0037.

= 0: Torque has been set to the value programmed in A-0-0038.

Idle speed achieved (_A:F#.25)

The drive is in control and has reached its idle speed.

Idle: S-0-0036 = A-0-0011

(See "Idle" section. 3.9)

Limit value negative/positive exceeded (_A:F#.28/29)

These outputs are only relevant in jog mode.

If an operating variable is changed via a jog input, then achieving the parametrized minimum/maximum limit value is signalled.

Cam table 2 active (_A:F#.30)

= 1: "Cam table 2" (P-0-0092) is active.

= 0: "Cam table 1" (P-0-0072) is active.

(See "Changing between cam profile 1 and 2" in section. 3.5)

In synchronization window (_A:F#.31)

Operating mode "speed synchronization".

The difference between the actual speed and the synchronous command speed is smaller than "velocity synchronization window" (S-0-0183).

Operating mode "angle synchronization", "cam" or "pattern control":

The difference of the actual position to the synchronous command position is smaller than "Position synchronization window" (S-0-0228).

90% - LOAD (_A:F#.32)

The drive is generating more than 90% of its present maximum torque.

100% relates to the value set in parameter "Active peak current" (P-0-4046).

Acknowledge idle speed bit 0 / bit 1 (_A:F#.33, _A:F#.34)

These outputs acknowledge the idle speed selection.

See inputs "Select idle speed bit 0 / bit 1" (_E:F#.33, _E:F#.34).

Register control - mark loss (_A:F#.37)

This output is set if too many register marks fail sequentially.

Process controller - act. diameter > reference diameter (_A:F#.38)

This output is relevant for the winding control with a dancer.

This output is set if the current diameter (A-0-0077) exceeds the reference diameter (A-0-0149).

This output is reset if the current diameter (A-0-0077) is smaller than reference diameter (A-0-0149).

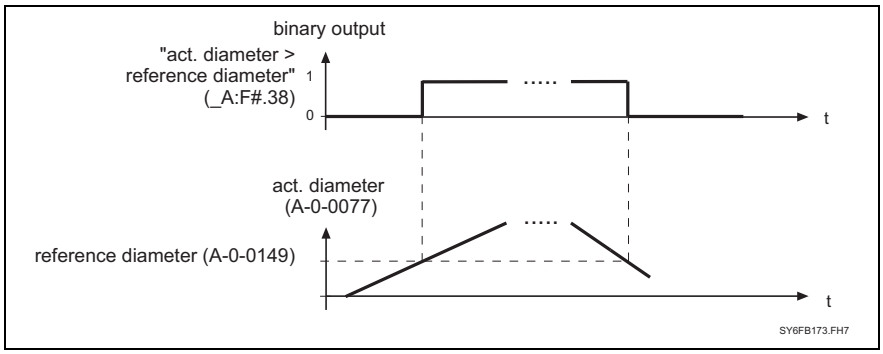


Fig. 4-33: Process controller - act. diameter > reference diameter (_A:F#.38)

Process controller - min. reel diameter exceeded (_A:F#.39)

This output is only relevant in conjunction with process controller function "winding controller with dancer".

This output is set if the current diameter (A-0-0077) is smaller than the diameter in parameter "process controller - minimum reel diameter" (A-0-0076).

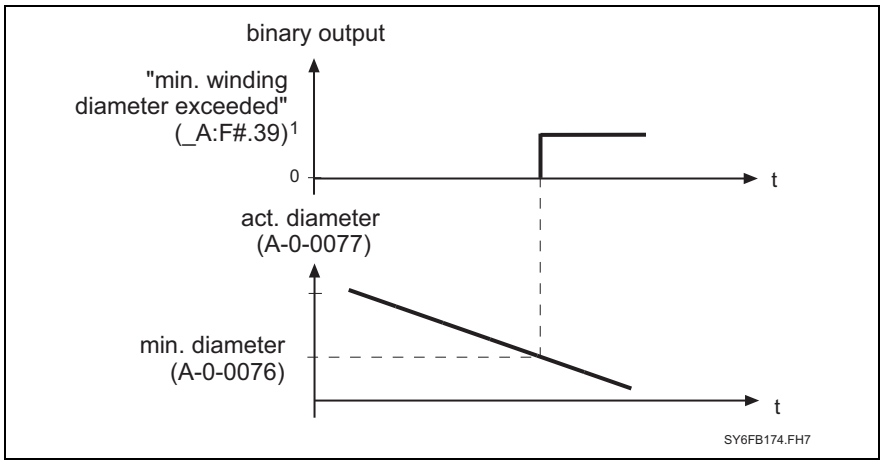


Fig. 4-34: Process controller - min. reel diameter exceeded (_A:F#.39)

Process controller - max. reel diameter exceeded (_A:F#.40)

This output is only relevant in conjunction with process controller function "winding controller with dancer".

This ouput is set if the current diameter (A-0-0077) is greater than diameter in parameter "process controller - maximum reel diameter" (A-0-0144).

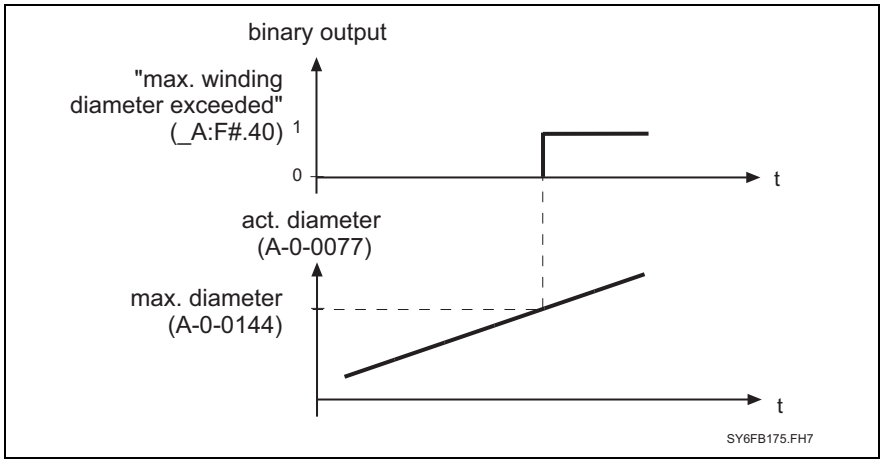


Fig. 4-35: Process controller - max. reel diameter exceeded (_A:F#.40)

Acknowledge synchronization mode - direction reversing (_A:F#.41)

This output is only relevant in synchronization or special operating modes.

It is set if the programmed rotational direction of the drive in its relationship to the master axis is inverted with binary input "synchronization mode - direction reversing" (_E:F#.41).

Drive cams

The dynamic cam switch of a drive makes up to eight outputs (cam) available.

Designation	Function
_A:W#.01	Drive cam switch 1
_A:W#.02	Drive cam switch 2
...	...
_A:W#.08	Drive cam switch 8

Fig. 4-36: Drive cam switches

Designation _A:W#.nn stands for the drive with address # (# = 1...40).

Pattern control inputs

There are the following inputs for the pattern control on the CLC:

Designation	Function
_E:M01.01	Pattern control - clear error

Fig. 4-37: Pattern control inputs

Pattern control outputs

There are the following outputs for the pattern control on the CLC:

Designation	Function
_A:M01.01	Pattern control - serial interface overflow
_A:M01.02	Pattern control - serial interface parity error
_A:M01.03	Pattern control - serial interface frame error
_A:M01.04	Pattern control - data buffer overrun
_A:M01.05	Pattern data - start byte fault
_A:M01.06	Pattern data - target position undefined
_A:M01.07	Pattern data - error in number of axes
_A:M01.08	Pattern data - checksum error
_A:M01.09	Pattern data - not in order
_A:M01.10	Pattern data - positive pattern limit exceeded
_A:M01.11	Pattern data - negative pattern limit exceeded
...	...
_A:M01.15	Pattern control - warning
_A:M01.16	Pattern control - error

Fig. 4-38: Pattern control outputs

Auxiliary markers

Auxiliary markers are organized in a 32 bit wide manner. They start, unlike most of the other I/Os, with the number 0.

Designation	Function
_A:H0.01	freely-definable auxiliary marker (longword no. 0)
_A:H0.02	freely-definable auxiliary marker (longword no. 0)
...	...
_A:H0.32	freely-definable auxiliary marker (longword no. 0)
_A:H#.01	freely-definable auxiliary marker (longword no. #)
_A:H#.02	freely-definable auxiliary marker (longword no. #)
...	...
_A:H#.32	freely-definable auxiliary marker (longword no. #)

Fig. 4-39: Auxiliary marker

CLC inputs

The following inputs exist for the CLC system:

Designation	Function
_E:C01.01	Clear CLC error
_E:C01.03	Clear CLC error external communikation
_E:C01.04	Clear CLC-link error
_E:C01.05	CLC-link - rebuild double ring

Fig. 4-40: System inputs

Clear CLC error (_E:C01.01)

This input serves to clear or acknowledge an error on the CLC.

In the table of possible errors (see "Trouble Shooting Guide") it is noted which error can be cleared with this input.

When clearing errors it is necessary that the input is applied until the output "CLC error" (_A:C01.02) disappears.

Clear CLC error of external communications (_E:C01.03)

This input serves to clear or acknowledge an error on the CLC.

In the table of possible errors (see "Trouble Shooting Guide") it is noted which error can be cleared with this input.

When clearing errors it is necessary that the input is applied until the output "CLC error" (_A:C01.02) disappears.

Clear CLC link error (_E:C01.04)

This input serves to clear or acknowledge an error on the CLC.

In the table of possible errors (see "Trouble Shooting Guide") it is noted which error can be cleared with this input.

When clearing errors it is necessary that the input is applied until the output "CLC error" (_A:C01.02) disappears.

CLC-link - rebuild double ring (_E:C01.05)

Setting the binary input "CLC-link - rebuild double ring" (_E:C01.05) triggers an automatic reconfiguration. If the reconfiguration was successful, then the binary error messages (_A:C01.05 ... _A:C01.07) are cleared.

Note: An external signal for automatic reconfiguration must effect all link participant inputs at the same time.

CLC outputs

The following outputs exist for the CLC system:

Designation	Function
_A:C01.01	CLC ready timing signal
_A:C01.02	CLC error
_A:C01.03	CLC error in external communications
_A:C01.04	CLC link error
_A:C01.05	CLC link - error primary optical ring
_A:C01.06	CLC link - error secondary optical ring
_A:C01.07	CLC link - redundancy loss
_A:C01.08	Fieldbus - real time channel active
_A:C01.09	CLC clock pulse in seconds
_A:C02.01	Link participant 1 data valid
_A:C02.02	Link participant 2 data valid
_A:C02.03	Link participant 3 data valid
...	...
_A:C02.32	Link participant 32 data valid

Fig. 4-41: CLC outputs

CLC ready timing signal (_A:C01.01)

This signal is cyclically toggeled by the CLC once it is ready to operate.

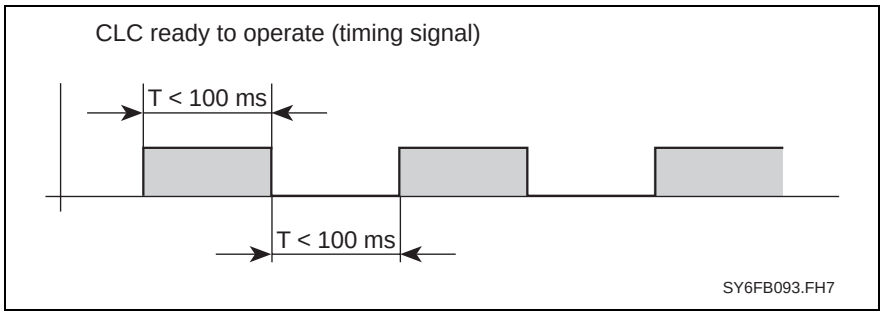


Fig. 4-42: CLC ready to operate (timing signal)

The CLC is not ready to operate if:

- it is not in operating mode (Sercos phase 4)
- the Sercos ring has failed
- there is a serious system error e.g., address bus error ...).

If this signal is applied to the DEA4.1 output _A:D#.16, then pin no. 32 (CLC_BB) on X17 of the DEA4.1 has the function of a CLC ready to operate contact.

Note: The signal on pin no. 20 in plug-in module DEA08 and the CLC plug-in card DEA28-30 automatically has the function of a CLC ready to operate contact. Allocation in the I/O logic is not necessary

For the DEA04 the following line is inserted in the source file of the I/O for this purpose:

R _A:C01.01 W _A:D01.16

CLC_BB_Timing signal at output 16 (pin31) and therefore

CLC_BB at pin32 of the DEA in the drive with address 1.

On the DEA04 output _A:D#.16 is monitored by the hardware. As long as it is toggled by the CLC, then the signal at pin no. 32 = 1. If toggling is interrupted, then this signal is removed.

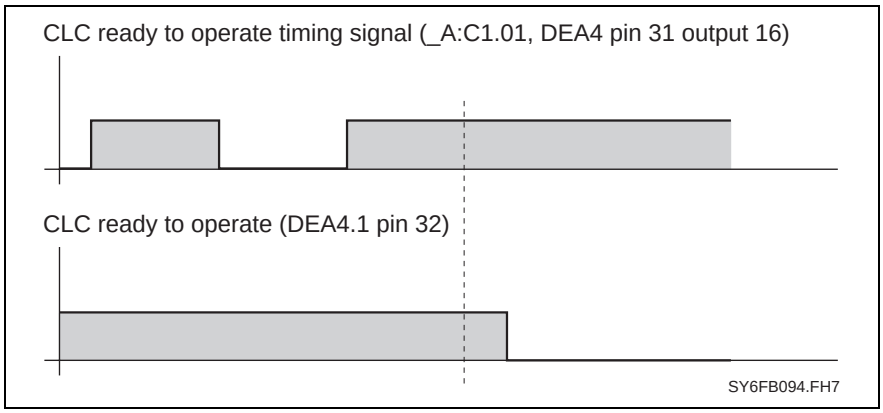


Fig. 4-43: CLC ready to operation (function principle)

CLC error (_A:C01.02)

This output is set if an error occurs at the CLC. If this output becomes active, then the virtual master, for example, should be stopped.

In the table listing possible errors (see "Trouble Shooting Guide") it is noted which error causes the setting of this output.

CLC error external communication (_A:C01.03)

This output is set if an error has occurred during communications with an external partner (3964R, ARCNET,...) which could possibly disrupt communications permanently.

In the table of possible errors (see "Trouble Shooting Guide") it is noted which error has brought about the setting of this output.

CLC link faulty (_A:C01.04)

This output is set if an error has occurred within the CLC link.

If this output becomes active, then the master axis, for example, should be stopped.

(See "Binary outputs in the link", section. 13.6)

CLC link error primary ring (_A:C01.05)

This output is set if an error has occurred in the primary ring of the CLC link with double ring.

(See "Single fault tolerance and diagnostics in the double ring", section. 13.9)

CLC link error secondary ring (_A:C01.06)

This output is set if an error has occurred in the secondary ring of the CLC link with double ring.

(See "Single fault tolerance and diagnostics in the double ring", section. 13.9)

CLC link redundancy error (_A:C01.07)

If a simple error in the CLC link (double ring) has been detected, then the redundancy of the double ring can no longer be guaranteed.

The CLC link will continue to work, however. The defect must be repaired as soon as possible.

Note: Another error causes a complete failure of the CLC link. (See "Single fault tolerance and diagnostics in the double ring", section. 13.9)

Fieldbus - rela time channel active (_A:C01.08)

This output is set if new process data are sent from the fieldbus master to the CLC within the PD monitoring time (fieldbus object 6003) in operating mode.

CLC clock pulse in seconds (_A:C01.09)

SYNAX uses an internal clock to record events. It can be read with the help of parameter "SYNAX - system time" (C-0-0159) in Windows time format.

As the transmission of the time value read by the CLC comes time delayed to a higher ranking control via a fieldbus connection by 2 second steps (Windows time format), this output "CLC clock pulse in seconds" (_A:C01.09) can be used to follow the actual course of the SYNAX system clock. Given an uneven number of seconds, the CLC output is set, in the reverse case it is deleted.

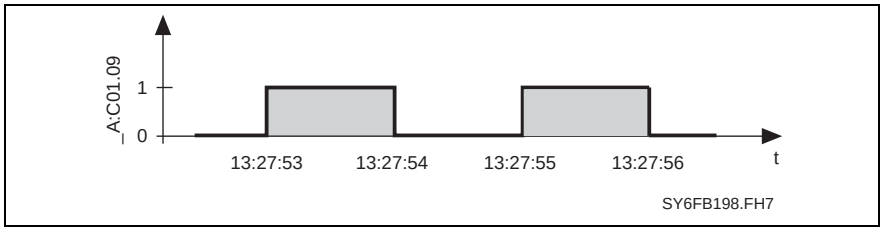


Fig. 4-44: CLC clock in seconds (funktional principle)

Link participant # data valid (_A:C02.01...32)

As soon as communications via the CLC link fiber optic cable ring is standing for the first time, then all possible 32 link participants of these outputs are set if:

1. the relevant participant is in the ring
2. the data sent by the participant are valid
3. the data received in the relevant link participant are valid

Example If a drive in the CLC ring follows address 4 of a master axis out of the ring with address 12, then output _A:C02.12 must be noted in CLC address 4.

R/S Flip-Flops

The CLC makes 32 R/S Flip-Flops available.

Set inputs Flip Flop 1-32

Designation	Function
_E:S01.01	Set input flip flop 1
_E:S01.02	Set input flip flop 2
. .	. .
_E:S01.32	Set input flip flop 32

Fig. 4-45: Flip Flop inputs

Reset inputs Flip Flop 1-32

Designation	Function
_E:R01.01	Reset input flip flop 1
_E:R01.02	Reset input flip flop 2
. .	. .
_E:R01.32	Reset input flip flop 32

Fig. 4-46: Flip Flop reset

Outputs Flip Flop 1-32

Designation	Function
_A:Q01.01	Output Q, Flip Flop 1
_A:Q01.02	Output Q, Flip Flop 2
. .	. .
_A:Q01.32	Output Q, Flip Flop 32

Fig. 4-47: Flip Flop outputs

Note: Reset has priority!

4.5 Allocating internal/external I/Os (I/O logic)

Each input/output depicted in the previous sections can be connected to other inputs and outputs via the I/O logic by means of logical elements and allocations.

The I/O logic on the CLC makes it possible to directly allocate external and internal I/Os, and AND/OR-links, signal inversions and the processing of auxiliary markers (markers).

Direct allocations

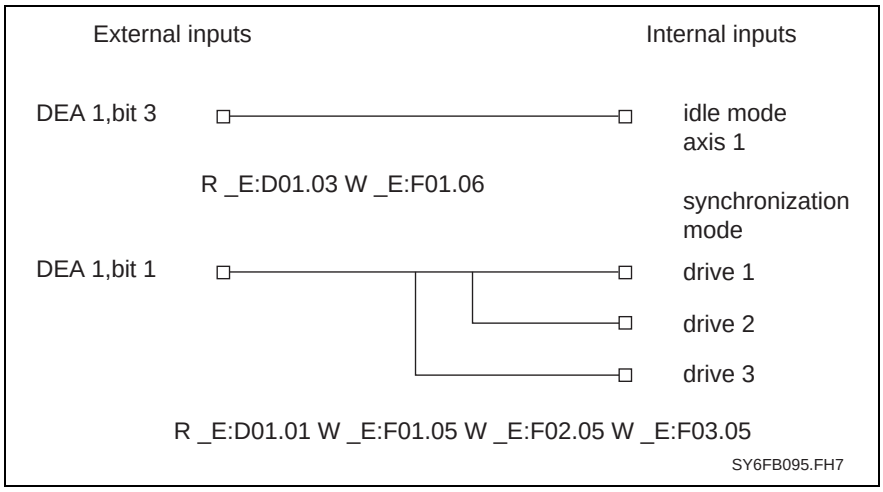


Fig. 4-48: Direct allocations

AND/OR links

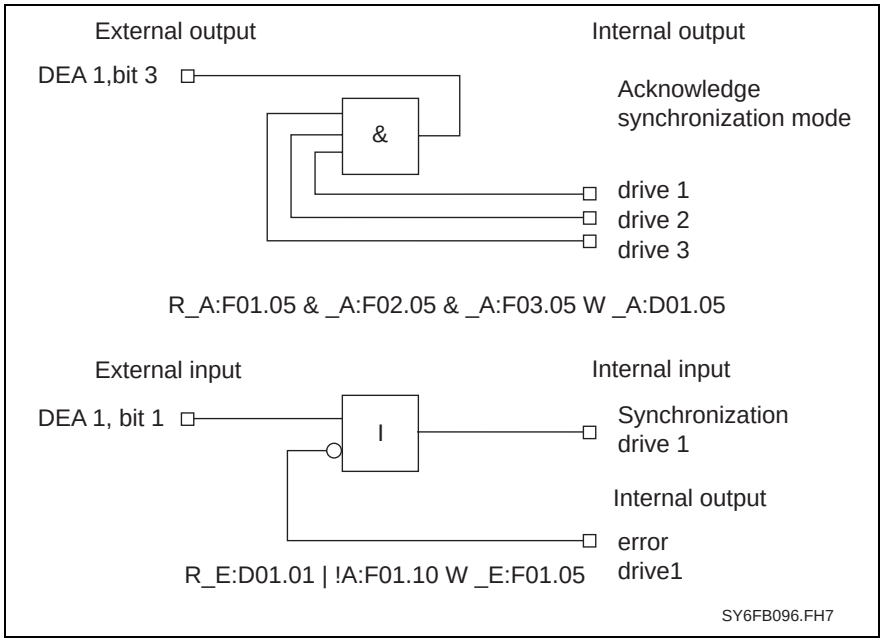


Fig. 4-49: AND/OR links

Using markers

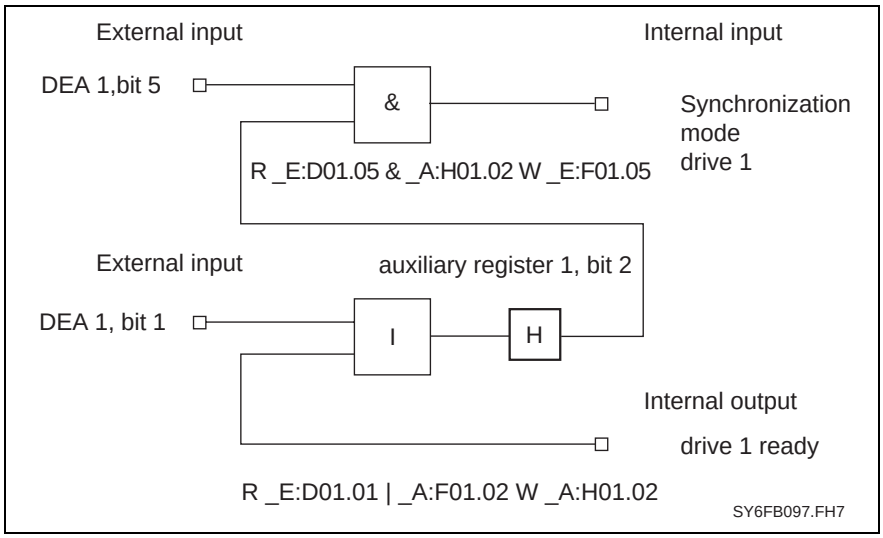


Fig. 4-50: Using markers

The allocation list

The allocation of internal/internal inputs/outputs is written in a simple programming language. All allocations are written into a file.

Once the contents of this file are translated by the translator included in the delivery, the thus generated file is be loaded into the CLC.

Example Allocation list:

```
* read DEA 1, bit 1, write to synchronization *
* drives 1 to 3 *
  R _E:D01.01 W _E:F01.05 W _E:F02.05 W _E:F03.05
* read drive 1 ready, OR-link with DEA 1, bit 1, write in marker 1, bit 2
  R _E:D01.01 ¦ _A:F01.02 W _A:H01.02
```

Fig. 4-51: Excerpt of an allocation list (*.TXT-file)

With the following call, file "Example.TXT" is translated:

>PARA EXAMPLE.TXT

The thus generated file has the suffix *.ASC (here "Example.ASC"). It is loaded with the CLC user interface with menu "PARAMETER Load" into parameter "I/O allocation int./ext. I/O" (C-0-0013).

The translation program "PARA.EXE" can be ordered with

SWA-SYNAX*-INB-.....

The current order designation is listed in the "SYNAX Reference List", section. 1.4 of this documentation.

Example Translated allocation list:

```
SERCOS-ASCII
20.12.1994 13:49:56
****************
****************
1
****************
|
C-0-0013
I/O allocation int./ext. I/O
01000000001101010000000000000001
--
--
--
00762          ⇒      length programmed in bytes
20000          ⇒      max. permissible length in bytes
0x0005         ⇒      version no.
0x0000         ⇒      PARA.EXE
0x7000
0x7200
0x7400
0x45F9
0x0000
0x02EC
0x0402
0xD5C9
0x1028
0x0327
0x0A00
......
......
0x0404
0x0606
0xDEC2         ⇒      Checksum
```

Fig. 4-52: Translated allocation list

4.6 I/O logic parameters

All relevant CLC systems parameters are listed below. For details see "SYNAX Parameter Description", DOK-SYNAX*-SY*-06VRS**-PA01-EN-P.

Parameter Number	Designation	
C-0-0089	List of all C parameters	S
C-0-0090	List of all A parameters	S
C-0-0091	Internal I/O: Master axis inputs	K
C-0-0092	Internal I/O: Master axis outputs	S
C-0-0093	Internal I/O: CLC inputs	K
C-0-0094	Internal I/O: CLC outputs 1	S
C-0-0095	Internal I/O: cam switch group 1	S
C-0-0096	Internal I/O: pattern control inputs	K
C-0-0097	Internal I/O: pattern control outputs	S
C-0-0098	Internal I/O: set inputs flip flop 1-32	K
C-0-0099	Internal I/O: reset inputs flip flop 1-32	K
C-0-0100	Internal I/O: outputs flip flop 1-32	S
C-0-0106	Internal I/O: CLC outputs 2	S
C-0-0110	Internal I/O: auxiliary register number	K
C-0-0111	Internal I/O: auxiliary register value	S
C-0-0112	External I/O: DEA28 inputs	S
C-0-0113	External I/O: DEA28 outputs	K
C-0-0114	External I/O: DEA29 inputs	S
C-0-0115	External I/O: DEA29 outputs	K
C-0-0116	External I/O: DEA30 inputs	S
C-0-0117	External I/O: DEA30 outputs	K
C-0-0118	External I/O: inputs of CLC-P or serial interface - number	K
C-0-0119	External I/O: inputs of CLC-P or serial interface - value	S
C-0-0120	External I/O: outputs CLC-P or serial interface - number	K
C-0-0121	External I/O: outputs CLC-P or serial interface - value	K
A-0-0101	Internal I/O: following axis inputs 1-32	K
A-0-0102	Internal I/O: following axis outputs 1-32	S
A-0-0103	Internal I/O: following axis outputs 33-64	S
A-0-0118	Internal I/O: following axis inputs 33-64	K

Fig. 4-53: I/O logic parameters

5 Tension control with a load cell

5.1 Function principle

The tension controller can be used to control the web tension. The current tension is measured using a load cell.

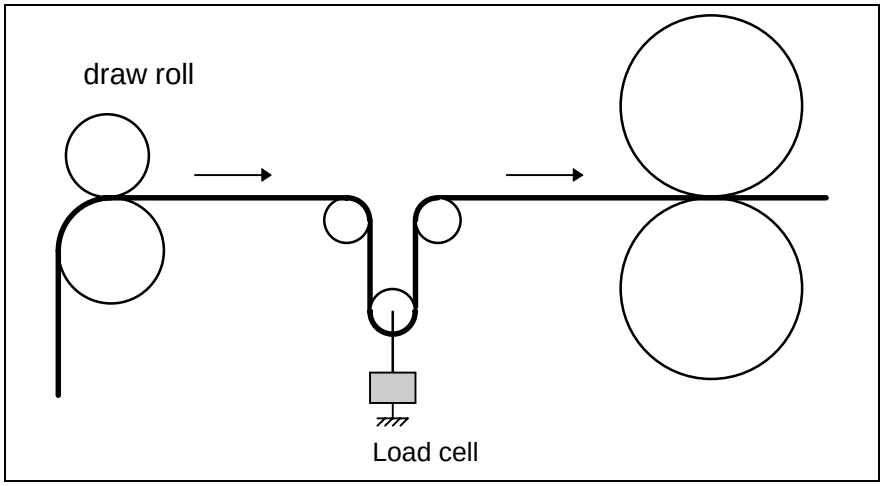


Fig. 5-1: Tension control example

The actual value of the tension is evaluated with the help of an analogue channel. Measurement is taken via a load cell. Measurements can be taken in front of or behind the draw roller.

The tension controller can be an adaptive PI-controller. The tension output affects the gear ratio between the master axis and the draw axis.

One tension controller can simultaneously work with several draw rollers.

5.2 Functions

Tension controller structure

The tension controller is a PI controller.

The controller can work either with a constant or speed-dependent proportional gain. Given an adaptive control, the p-gain follows linearly with the master axis speed. The curve is fixed with parameters "process controller 1 - p-gain adaption operation point 1" (A-0-0130) and "process controller 1 - p-gain adaption operation point 2" (A-0-0131).

The adaptive control is configured in "process control - control word 2" (A-0-0146).

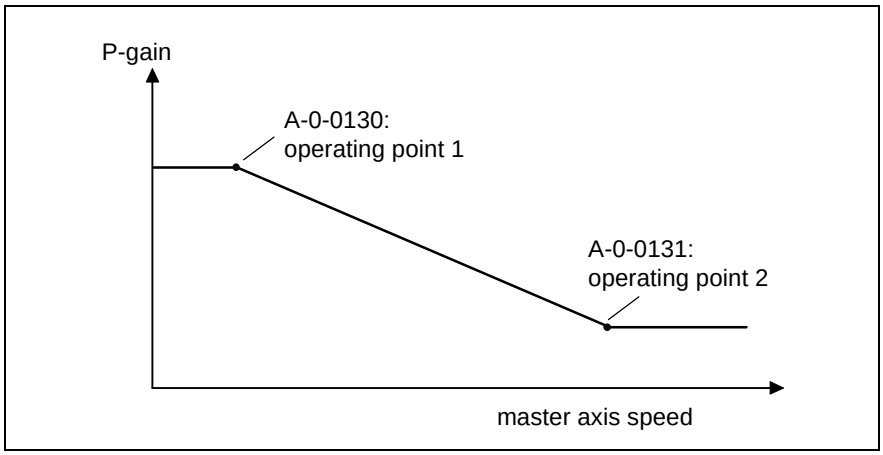


Fig. 5-2: P-gain adaption

Manipulated variable (controller output)

Depending on the synchronization mode of the draw axis different parameters can be configured as manipulated variable:

Sync. mode	Configurable manipulated variable
speed synchronization	"Gain adjust" (P-0-0083) "Master drive gear - output revolutions" (P-0-0157)
phase synchronization	"Master drive gear - output revolutions " (P-0-0157)

Fig. 5-3: Manipulated variables for tension control

The controller output is limited with the use of two parameters in positive and negative direction. With a preset input the controller output can be set to a pre-parametrized value.

Depending on the synchronization mode the following parameters are effective:

Speed synchronization

- "Process controller - actual value 1 (fine adjustment)" (A-0-0067),
- "Process controller - positive limit 1" (A-0-0068),
- "Process controller - negative limit 1" (A-0-0069),
- "Process controller - preset 1 (fine adjustment)" (A-0-0075).

Phase synchronization

- "Process controller - actual value 3 (master axis gear)" (A-0-0140),
- "Process controller - positive limit 3" (A-0-0141),
- "Process controller - negative limit 3" (A-0-0142),
- "Process controller - preset 3 (master axis gear)" (A-0-0143).

Command value setting

The command value can be specified in digital (parameter A-0-0026) or analogue form.

If the command value is set via parameter A-0-0026, then the parametrized value can also be changed via the CLC jog function (see chapter 11, "Jogging function").

Feedback value detection

The control processes actual analogue values. Measurement arrangement is configured in "process control - control word 2" (A-0-0146).

Monitoring and diagnosis of the tension control

Actual tension value (A-0-0027) and tension command value (A-0-0026) can be displayed for diagnostic purposes.

The actual tension value is continuously checked to see whether a programmable window is maintained and whether the programmable maximum or minimum are exceeded. The tripping of a monitor is signalled to the PLC (see "Binary outputs of the tension control" on page 5-5).

Controlling several axes

One controller can work with up to four draw rollers. The simultaneous control of several axes is configured in "process control - control word 2" (A-0-0146). The addresses of the tension axes is entered in parameter "process control - drive addresses" (A-0-0087).

5.3 Binary I/Os of the tension control

Overview binary I/Os of the tension control

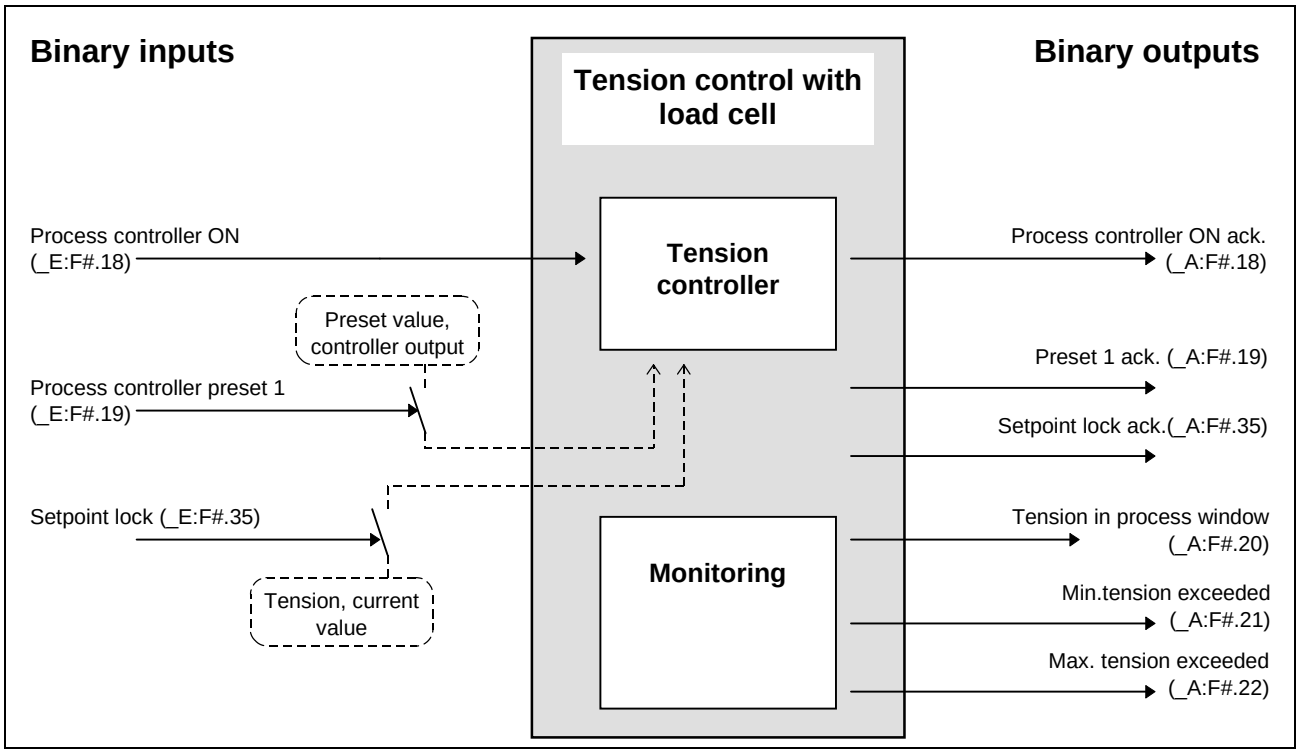


Fig. 5-4: Binary I/O: Tension control with load call

Binary inputs of the tension control

Designation	Function
_E:F#.18	process controller ON
_E:F#.19	process controller preset 1
_E:F#.35	process control - setpoint lock

Fig. 5-5: Binary inputs of the tension control

Activating tension control (_E:F#.18)

Tension control is activated by setting input "process controller ON" (_E:F#.18) to ’1’. The status of the control is signalled via output "process controller ON acknowledge" (_A:F#.18).

Preset function (_E:F#.19)

This input can be used to precisely set individual tension controllers. If the input is switched to ’1’, then the control output is set to a preprogrammed value. The CLC then acknowledges the output with "process controller preset 1 ack." (_A:F#.19). This acknowledgement is applied until input "process controller preset 1" (_E:F#.19) is preset.

Depending on the configured manipulated variable the preset value is parametrized in "process controller - preset 1 (fine adjustment)" (A-0-0075) or "process controller - preset 3 (master axis gear)" (A-0-0143).

Note: The preset input is only evaluated if the tension control is not activated ("process controller ON" to ’0’).

Setpoint lock (_E:F#.35)

If input "Process control - setpoint lock" is set, then the current tension feedback value is accepted as the new command value for the tension controller.

Binary outputs of the tension control

Designation	Function
_A:F#.18	Process controller ON ack.
_A:F#.19	Process controller preset 1 ack.
_A:F#.20	Process variable in process window
_A:F#.21	Min. process variable exceeded
_A:F#.22	Max. process variable exceeded
_A:F#.35	Process control - setpoint lock acknowledge

Fig. 5-6: Binary outputs of the tension control

Monitoring tension control

There are three binary outputs available for monitoring the actual value:

- "Process variable in process variable window" is set if the actual value of the tension control lies within a programmable range ("process variable window" (A-0-0061)).
- "Minimum process variable exceeded" is set if the actual value of the tension exceeds the programmed minimum value "minimum process variable - monitoring window" (A-0-0063).
- "Maximum process variable exceeded" is set if the actual value of the tension exceeds the programmed highest value "maximum process variable - monitoring window" (A-0-0062).

5.4 Block diagram

Tension controller affecting parameter "Gear ratio - fine adjustment"

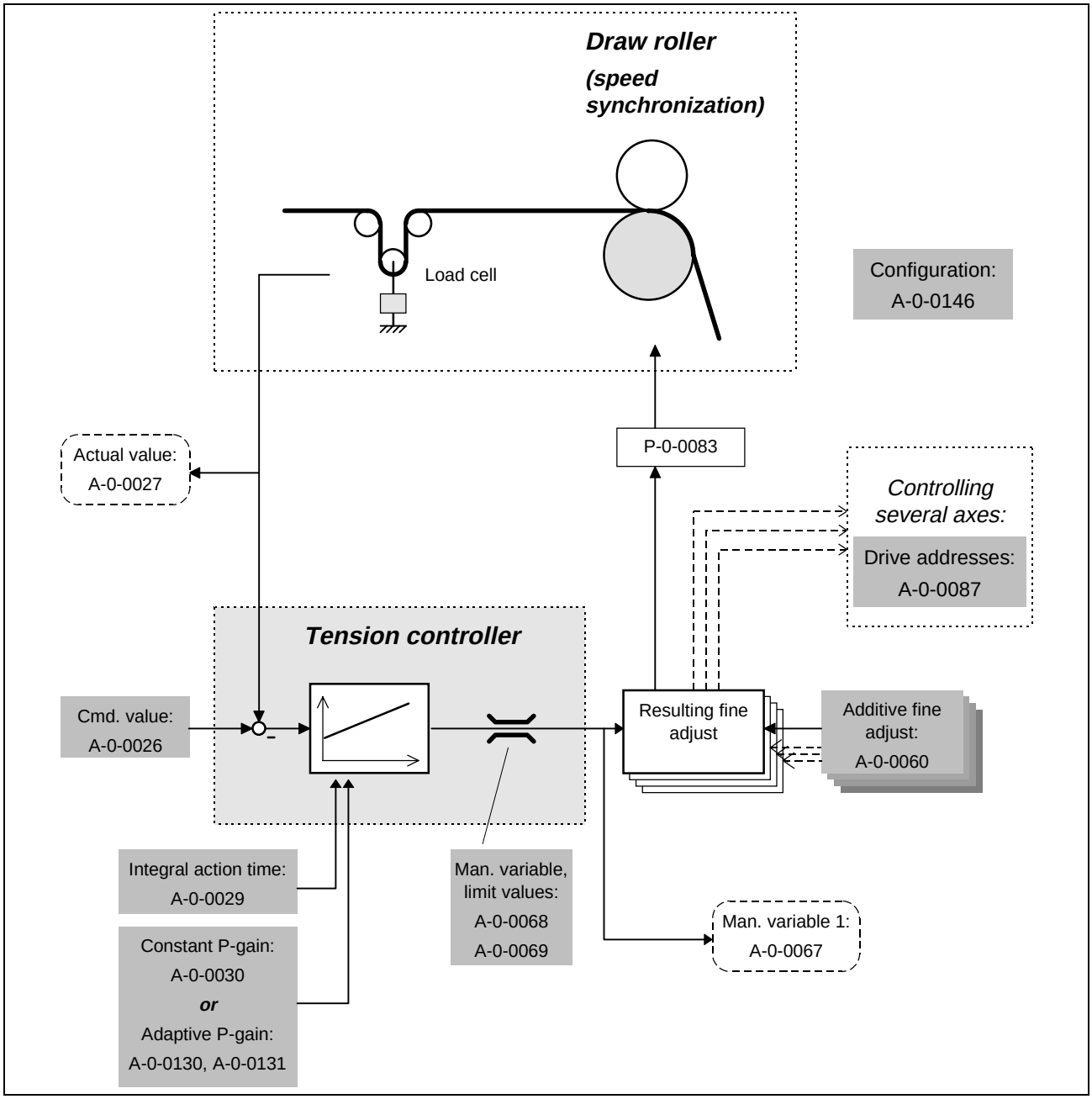


Fig. 5-7: Tension control; man. variable "gear ratio - fine adjustment"

Tension controller affecting parameter "Master axis gear - output revolutions"

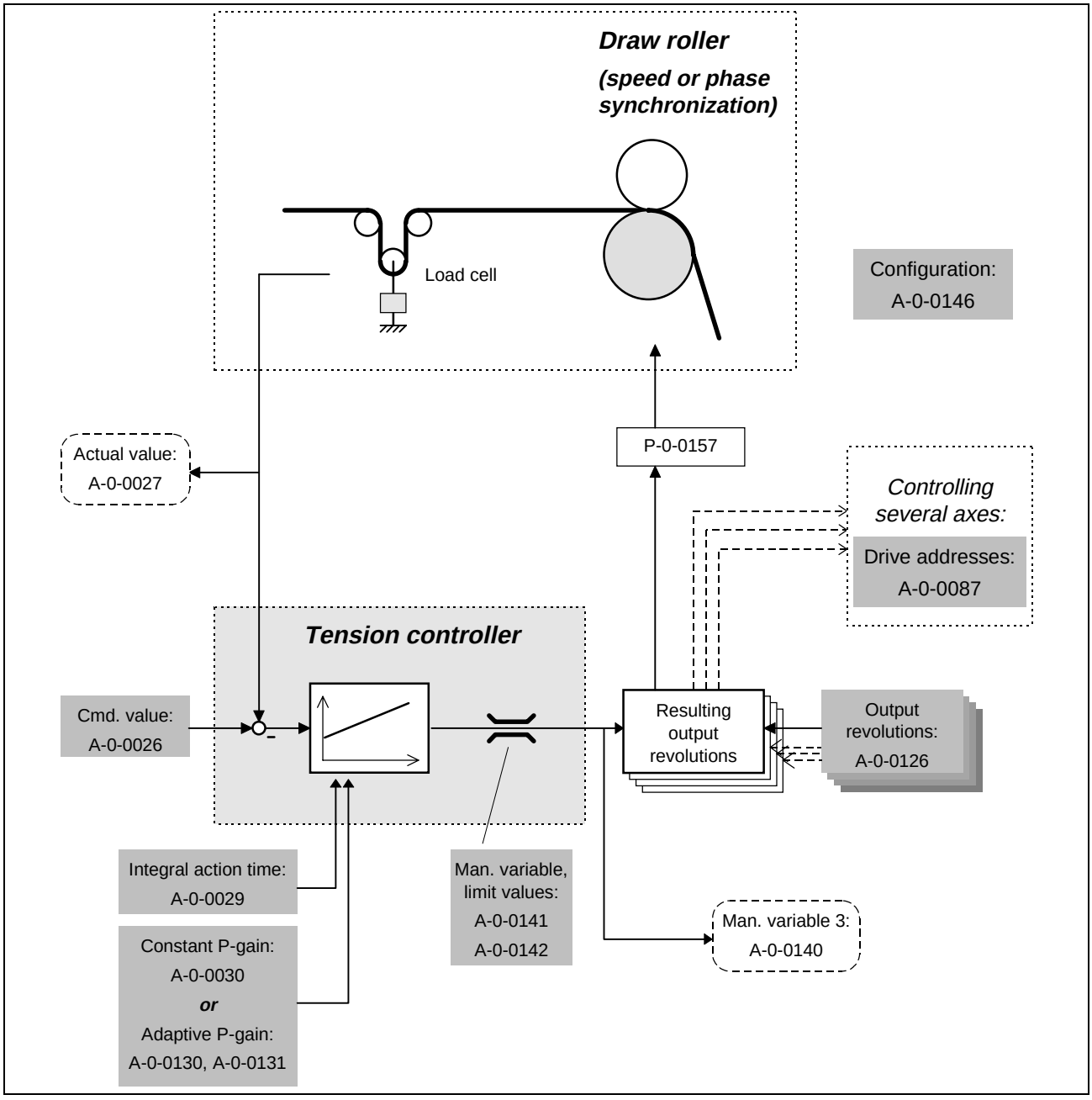


Fig. 5-8: Tension control; man. variable "master axis gear - output revolutions"

5.5 Tension control parameters

Listed below are all relevant CLC systems parameters for tension control. (For details see "SYNAX Parameter Description", DOK-SYNAX*-SY*-06VRS**-PA01-EN-P.)

Parameter number	Designation
A-0-0026	Process command value 1
A-0-0027	Process actual value
A-0-0028	Analogue channels - analogue input weighting
A-0-0029	Process controller - integral action time 1
A-0-0030	Process controller - proportional gain 1
A-0-0060	Fine adjustment
A-0-0061	Process variable window
A-0-0062	Maximum process variable - monitoring window
A-0-0063	Minimum process variable - monitoring window
A-0-0064	Process variable increments
A-0-0065	Analogue channels - analogue input offset
A-0-0066	Analogue channels - smoothing time constant
A-0-0067	Process controller - actual value 1 (fine adjustment)
A-0-0068	Process controller - positive limit 1
A-0-0069	Process controller - negative limit 1
A-0-0075	Process controller - preset 1 (fine adjustment)
A-0-0087	Process control - drive addresses
A-0-0130	Process controller 1 - p-gain adaption operation point 1
A-0-0131	Process controller 1 - p-gain adaption operation point 2
A-0-0140	Process controller - actual value 3 (master drive gear)
A-0-0141	Process controller - positive limit 3
A-0-0142	Process controller - negative limit 3
A-0-0143	Process controller - preset 3 (master drive gear)
A-0-0146	Process control - control word 2
A-0-0160	Process controller - bipolar speed operation point 2

Fig. 5-9: Parameters for tension control with a load cell

6 Dancer Control

6.1 Function principle

The dancer control can be used e.g. for draw rollers with a dancer. The dancer control controls the dancer position.

The tension is set by a force applied at the movable part of the dancer. This force can be applied by weight or pneumatics.

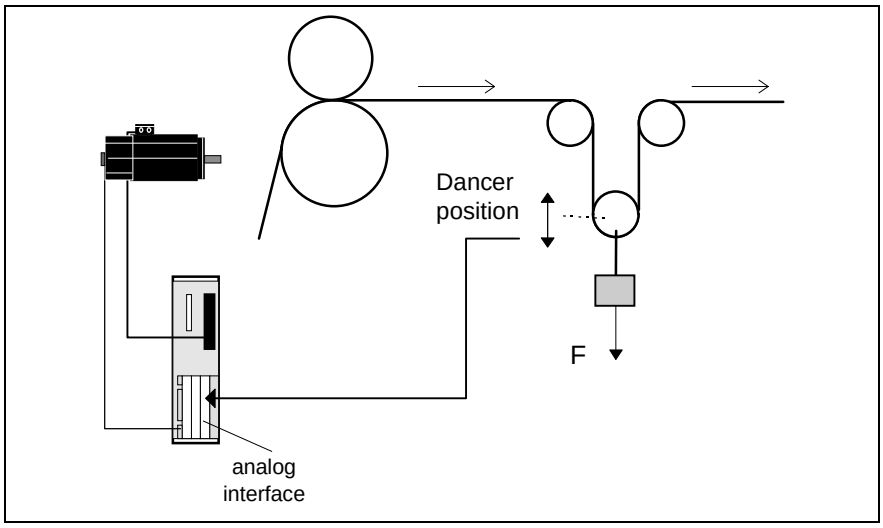


Fig. 6-1: Dancer control

The actual value of the dancer position is evaluated through the use of an analog channel.

One dancer control can simultaneously effect several draw rollers.

6.2 Functions

Dancer control

The dancer control is a PI-controller. The proportional gain and integral action time is set using parameters “process controller - proportional gain 1“ (A-0-0030) and “process controller - integral action time 1“ (A-0-0029).

The dancer control effects the "additive velocity command value" (S-0-0037) of the draw axis.

The polaritiy of the manipulated variable (control polarity) is set in "process control - control word 2" (A-0-0146).

Controller output limitations

The controller output limitation follows linearly with the master axis speed. The linear curve is fixed with parameters

- “Process controller - bipolar limit value 2 op. point 1“ (A-0-0150),
- "Process controller - positive limit 2 operation point 2" (A-0-0138),
- "Process controller - negative limit 2 operation point 2" (A-0-0139),
- "Process controller - bipolar speed operation point 2" (A-0-0160).

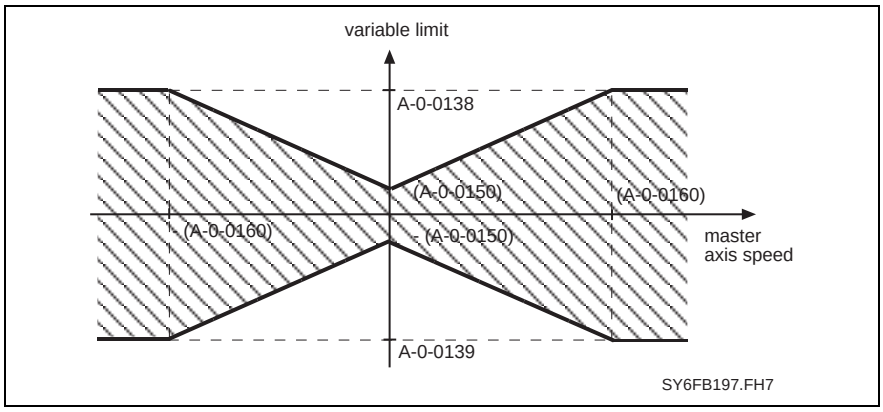


Fig. 6-2: Controller output limitations

The "bipolar limit value reduced" limits the speed with which the dancer moves during machine standstill in its command position.

Command value setting

The command value for the dancer position can be either digital (A-0-0026) or analog.

Note: The dancer control requires a positive command value.

If the command value is set via parameter A-0-0026, then the parametrized value can be changed even with the CLC jogging function. To direct the jog inputs to the dancer position command value it is necessary to set parameter "jogging mode with speed synchronization" (A-0-0013) to a value of "2".

Actual value detection

The dancer control processes analog actual values. The method of measuring is configured in "process control - control word 2" (A-0-0146).

As the dancer control processes positive command values only, also the current value must lie within a positive range. If the measurement results in bipolar or negative values, then the measured signal must be converted into a positive signal using an offset.

Example:

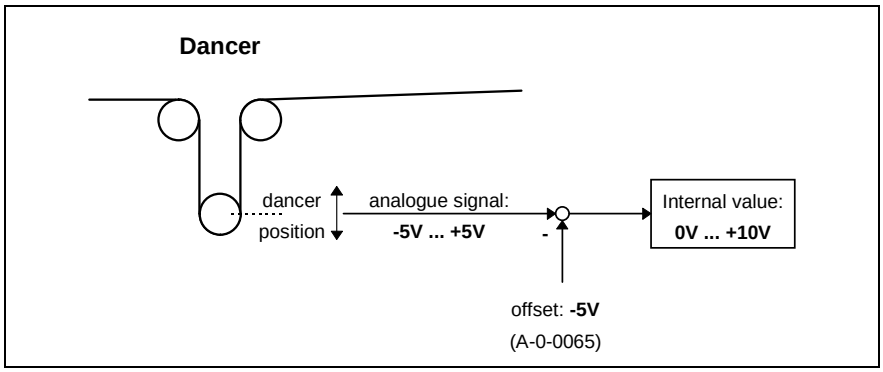


Fig. 6-3: Dancer position, current value scaling

Monitoring and diagnoses of the dancer control

Dancer

The dancer position actual value (A-0-0027) and the controller output (A-0-0137) can be displayed for diagnostic purposes.

The dancer position is continuously checked for maintaining programmed windows (A-0-0061) and exceeding programmed limit values (A-0-0062, A-0-0063). If the monitor is actuated, then the PLC receives a signal from the binary outputs (see "Binary outputs of the dancer control" on page 6-5).

Controlling several axes

One controller can control up to four draw axes. The simultaneous control of several axes is configured in "process control - control word 2" (A-0-0146). The addresses of the tension axes are entered in parameter "process control - drive addresses" (A-0-0087).

6.3 Binary I/Os of the dancer control

Overview binary I/Os of the dancer control

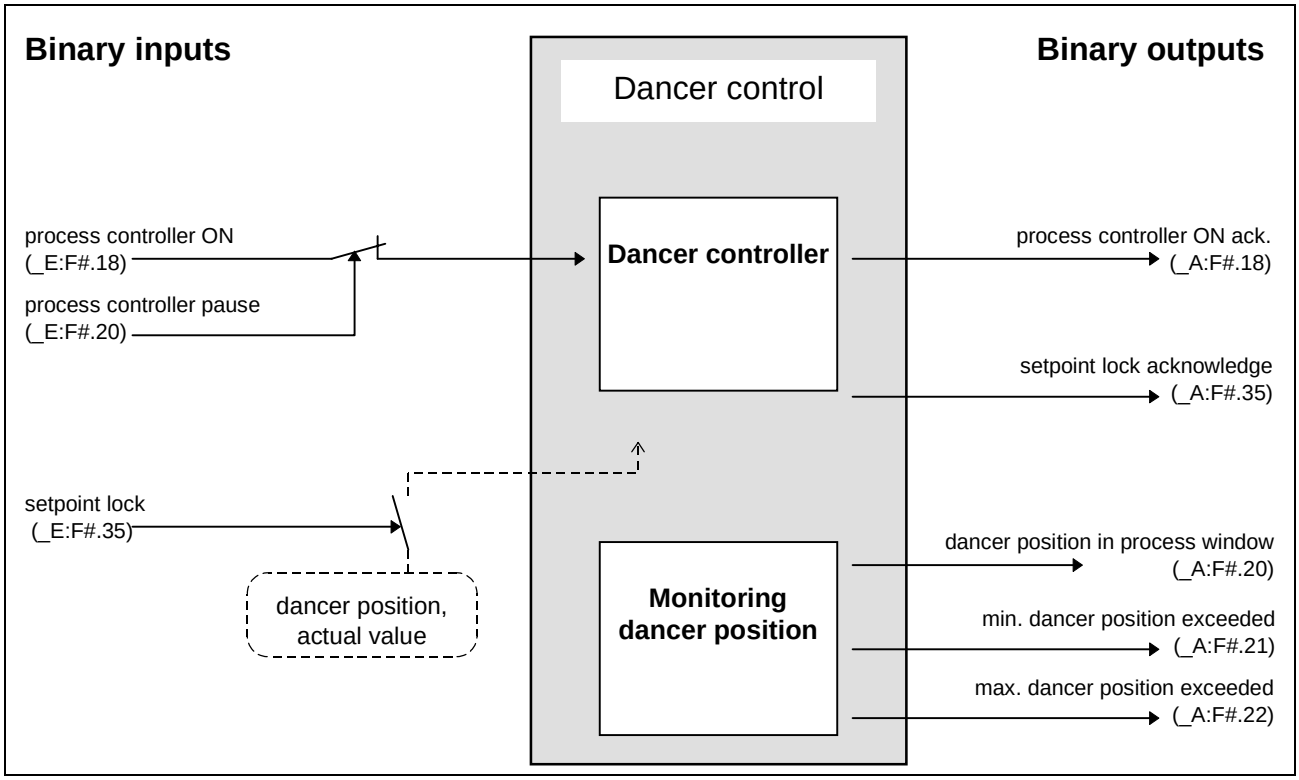


Fig. 6-4: Binary I/O: dancer control

Binary inputs of the dancer control

Designation	Function
_E:F#.18	process controller ON
_E:F#.20	process controller pause
_E:F#.35	process controller - setpoint lock

Fig. 6-5: Binary inputs of the dancer control

Activating the dancer controller (_E:F#.18)

The dancer control is activated with binary input "process controller ON" (_E:F#.18). Upon activation of the controller, all internal variables and controller outputs are reset. Upon deactivation, the controller outputs are reset. The status of the dancer control is signalled via output "process controller ON ack." (_A:F#.18).

Process controller pause (_E:F#.20)

The manipulated variable of the dancer control is ‘frozen’ as long as the input "process controller pause" (_E:F#.20) is set.

Process controller setpoint lock (_E:F#.35)

If input "process controller - setpoint lock" (_E:F#.35) is set, then the current dancer position actual value is set as a new command value for the dancer control.

Binary outputs of the dancer control

Designation	Function
_A:F#.18	process controlller ON ack.
_A:F#.20	process variable in process window
_A:F#.21	minimum process variable exceeded
_A:F#.22	maximum process variable exceeded
_A:F#.35	process controller - setpoint lock acknowledge

Fig. 6-6: Binary outputs of the dancer control

Process controller ON ack. (_A:F#.18)

This output acknowledges the activation of the dancer control ("process controller ON", _E:F#.18).

Monitoring dancer position

For actual value monitoring, there are three binary outputs available:

- **"process variable in process window" (_A:F#.20)** is set if the actual dancer position value lies within a programmable range (A-0-0061, "process variable window").
- **"minimum process variable exceeded" (_A:F#.21)** is set if the actual dancer position value exceeds the programmed minimum value "minimum process variable - monitoring window" (A-0-0063).
- **"maximum process variable exceeded" (_A:F#.22)** is set if the actual dancer position value exceeds the programmed maximum value "maximum process variable - monitoring window" (A-0-0062).

Process controller - setpoint lock acknowledge (_A:F#.35)

Output "process controller - setpoint lock acknowledge" (_A:F#.35) acknowledges the acceptance of the current actual dancer position value as a new command value for the dancer control.

6.4 Block Diagram

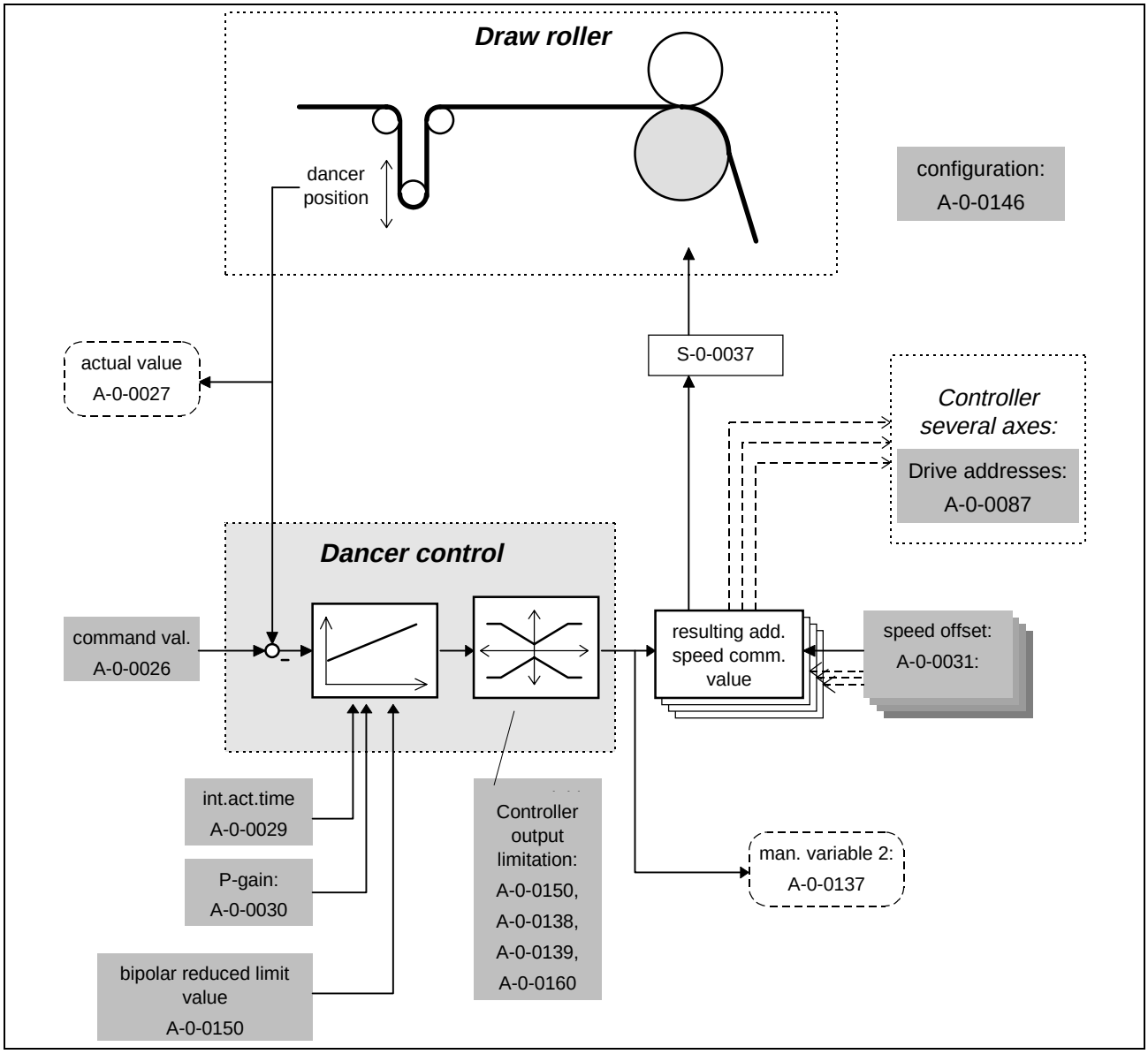


Fig. 6-7: Block diagram: dancer control

6.5 Parameter overview of the dancer control

The table below lists the dancer control relevant CLC system parameters.

(For detailed description see "SYNAX Parameter Description", DOK-SYNAX*-SY*-06VRS**-PA01-EN-P)

Parameter number	Designation
A-0-0026	Process command value 1
A-0-0027	Process actual value
A-0-0028	Analogue channels - analogue input weighting
A-0-0029	Process controller - integral action time 1
A-0-0030	Process controller - proportional gain 1
A-0-0061	Process variable window
A-0-0062	Maximum process variable - monitoring window
A-0-0063	Minimum process variable - monitoring window
A-0-0064	Process variable increments
A-0-0065	Analogue channels - analogue input offset
A-0-0066	Analogue channels - smoothing time constant
A-0-0087	Process control - drive addresses
A-0-0137	Process controller - actual value 2 (additive velocity)
A-0-0138	Process controller - positive limit 2 operation point 2
A-0-0139	Process controller - negative limit 2 operation point 2
A-0-0146	Process control - control word 2
A-0-0150	Process controller - bipolar limit value 2 op. point 1
A-0-0160	Process controller - bipolar speed operation point 2

Fig. 6-8: Parameters for dancer control

7 Register control

7.1 Introduction

Register control is a process control function located on the CLC command card.

The term "process control" defines a group of functions that are run on the CLC in real time. This includes tension and register control as well as the winding control. For each following axis, one process control function can be activated. Each process control function has its own group of parameters allocated to it. The binary I/Os generally relate to the process control.

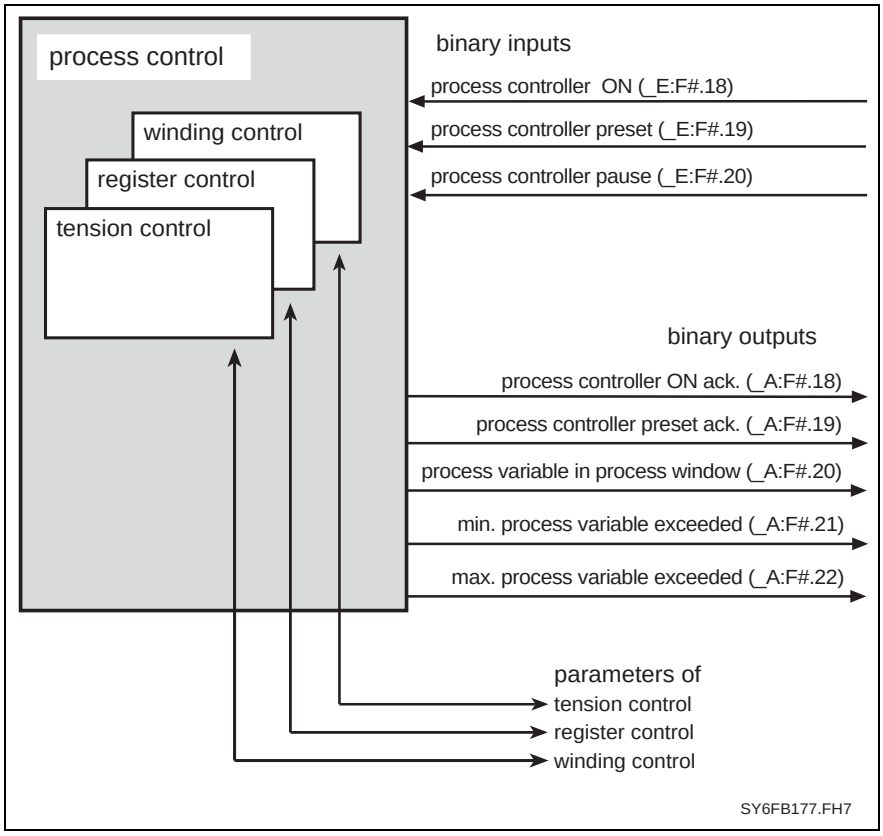


Fig. 7-1: Structure of the process control

7.2 Functions

The register control regulates the position of material in terms of the position of a reference axis. This can, for example, be the position of a board as it relates to the printing cylinder.

Control is conducted with the help of an electrical input signal at the reference axis. The electrical input signal is provided, for example, by optically probing a register marker on the material.

The register control detects the control deviation and differentiates between

- register control with position measurement (CLC internal calculation of the correcting path) and
- register control with time measurement (the corrective path input by external register control).

The register control contains the processes

- of a rapid individual control (direct correction) and
- a mean value correction (indirect correction).

It is possible to combine both in ***one*** controller.

One register control can affect several axes.

Register control with position measurement

Detecting a marker or the edge of sheet with "register control with position measurement" is conducted optically, for example.

Register marks on the web are optically probed.

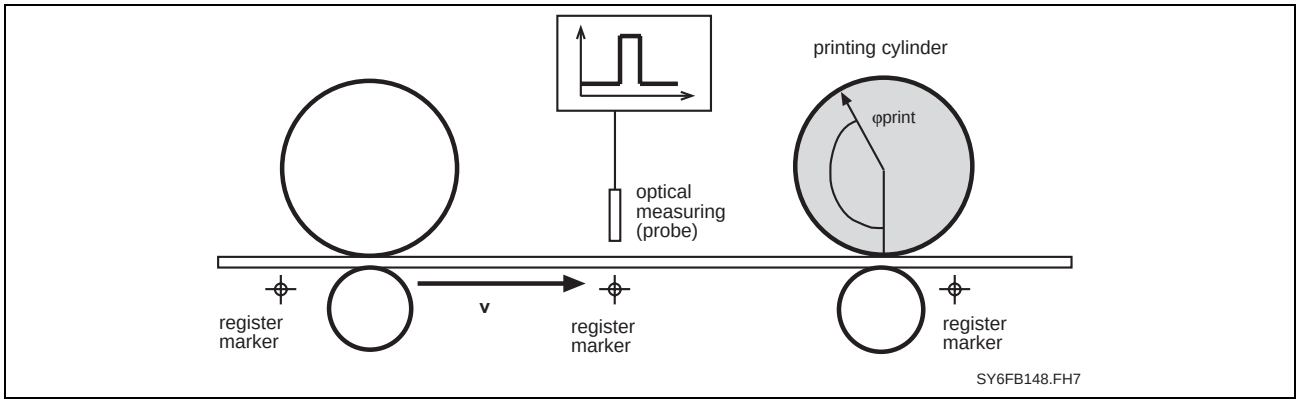


Fig. 7-2: Measuring principle with web printing

With sheet printing, either the edge of the sheet or a register mark is optically detected.

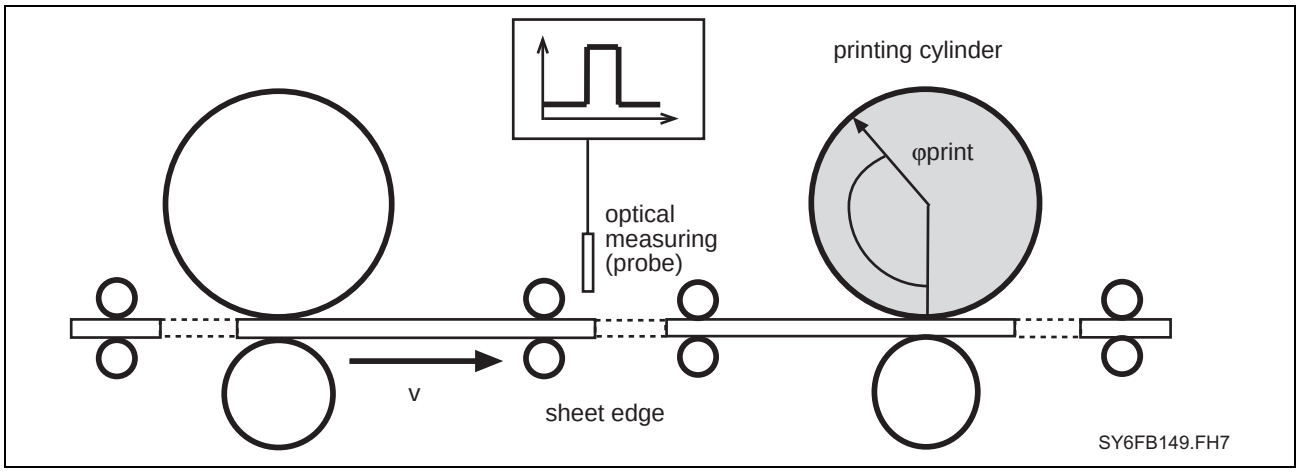


Fig. 7-3: Measuring principle of sheet printing

The output signal of the marker detection is fed to a measuring axis as a trigger signal. The measuring variable is detected by the edge of the output signal (measuring probe function in the drive). Depending on the mode of the measuring axis, the load-related actual position value of the drive or the master axis position can be selected as the measuring variable. The difference between measuring variable and a position command value for the signal edge is to determine the correcting angle around which an axis must be adjusted.

Connecting the measuring signal

The measuring signal is connected at the measuring probe input of the "DSS" plug-in card. Any two register controls can be assigned to inputs E4 and E5.

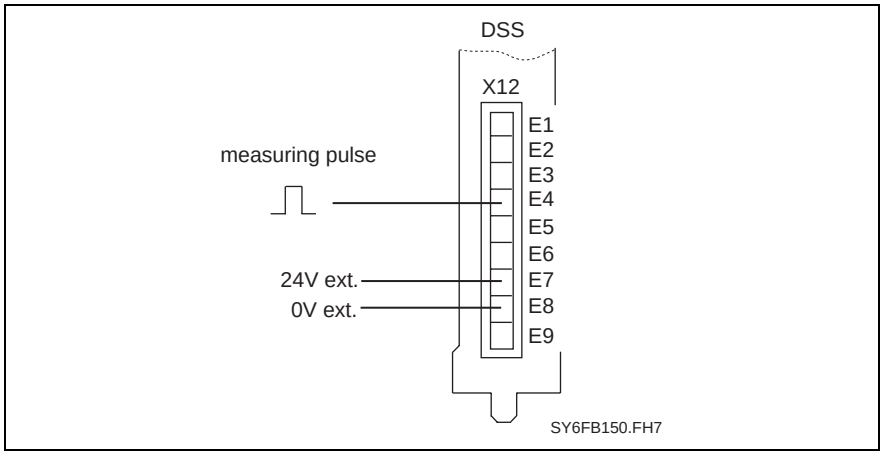


Fig. 7-4: Example of connecting the measuring pulse with position measurement

Note: With drive firmware 05VRS (or later versions) probe input 2 (E5) is no longer available for register control with position measurement.

Register control with time measurement (external control)

"Register control with time measurement" is used there where an external register control is used. The register control on the CLC control board conducts corrective movements fixed by the external controller.

The externally determined control deviation is given to the CLC via two binary inputs. A pulse-width modulated signal and a binary level determine both the amount and the operational sign of the control deviation.

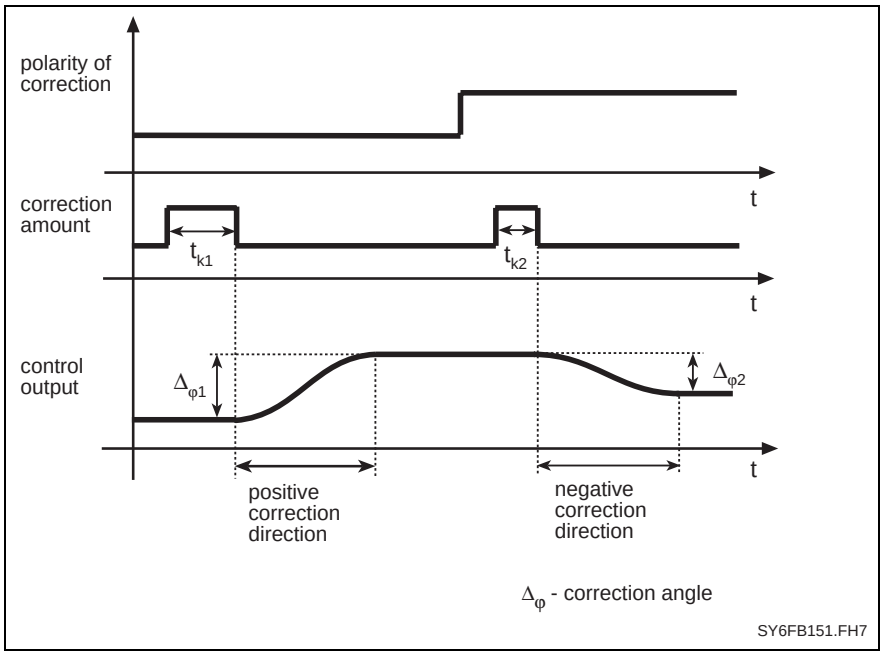


Fig. 7-5: Input signals of an external register control

The pulse width t_k of the signal "correction amount" is a dimension for the correction angle. The scaling for this signal is set in parameter "register control - time measurement weighting" (A-0-0098).

Both signals are hooked up at connector X12 of the DSS plug-in card on the measuring axis. The allocation of the measuring probe inputs E4 and E5 can be parametrized.

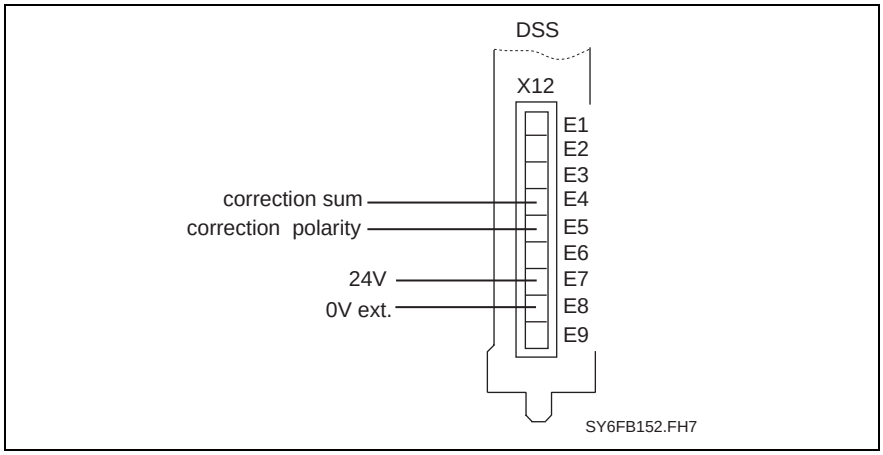


Fig. 7-6: Example: correction signal of an external register control

Correction processes

Direct correction

Direct corrections correct each individual value measured. Angle deviations (angle of correction) are corrected within a fixed correction path. This means, for example, when printing sheets, that the correction is already concluded as soon as the sheet meets the printing cylinder.

Corrections are conducted and completed within a correction window. The correction value is changed incrementally in accordance with a parabolically shaped correction profile. A new correction value is generated for each register control cycle.

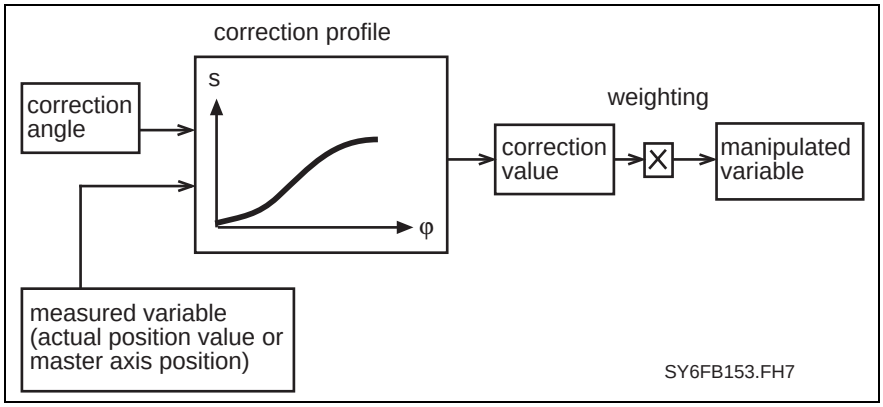


Fig. 7-7: Correction procedure for direct register control

Indirect correction

Indirect correction controls the long-term mean value of the control difference to zero. An application, for example, is a rapidly-running web printer. Available for this purpose is a parametrizable PI controller with adjustable control deviation smoothing.

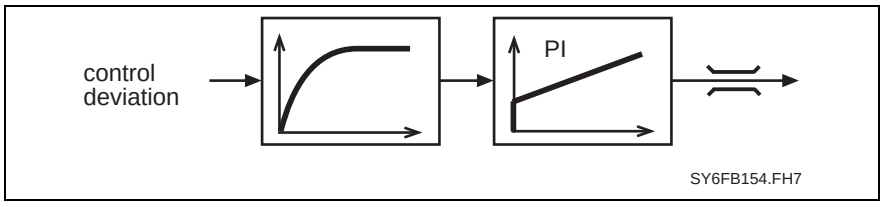


Fig. 7-8: The structure of indirect register control

Manipulated variables

The register control uses the following parameters as manipulated variables:

Operating mode of the controlled axis	Manipulated variable
phase synchronization	"position command value additional" (S-0-0048) or "master drive gear - output revolutions" (P-0-0157)
speed synchronization	"additive velocity command value" (S-0-0037) "gain adjust" (P-0-0083) or "master drive gear - output revolutions" (P-0-0157)
electronic cam	"Phase offset begin of profile" (P-0-0061), "position command value additional" (S-0-0048), "cam shaft distance" (P-0-0093) or "master drive gear - output revolutions" (P-0-0157)

Fig. 7-9: Manipulated variables of the register control

Correcting several axes

When correcting several axes, the actual position value of ***one*** drive is probed. The control, however, effects several axes. The following Figure demonstrates an example of this principle. The position of the printing cycle is probed and axes 1 through 4 are corrected.

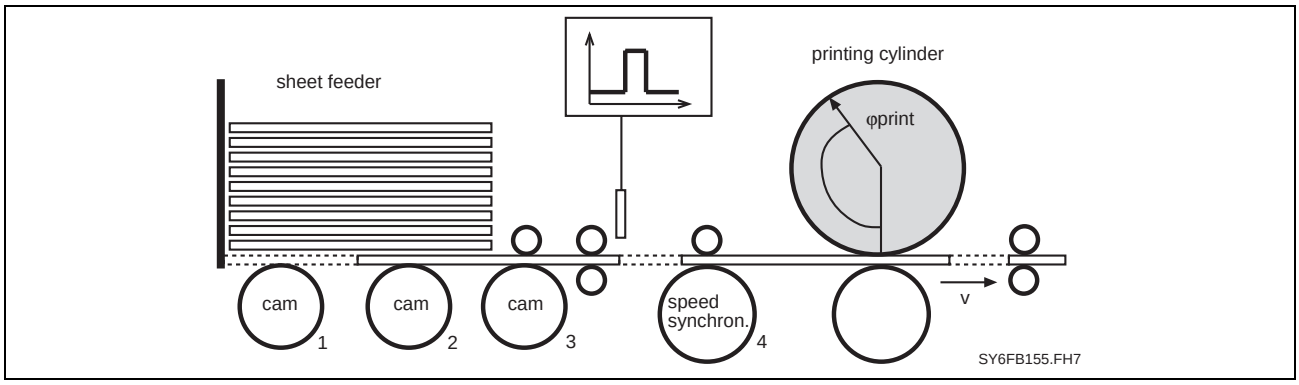


Fig. 7-10: An example of correcting several axes

The register control is allocated to that axis of which the actual position is used by the measuring probe function for the purpose of control. This means that the control parameters are entered at only one axis, i.e., the measuring axis.

General definition of terms

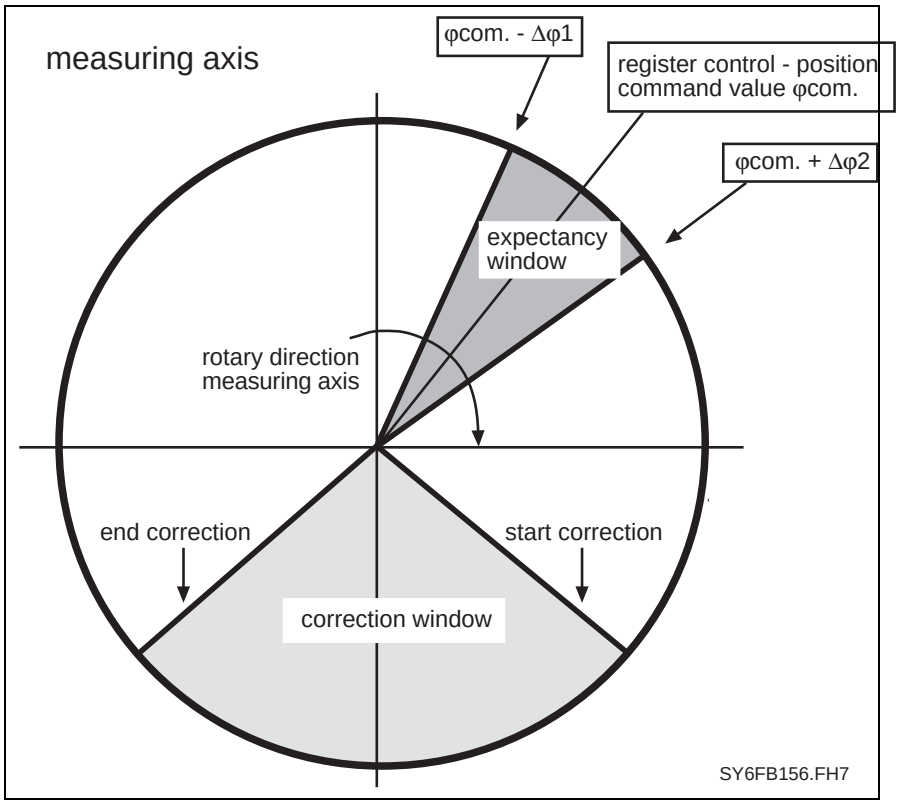


Fig. 7-11: Expectancy and correction windows at the measuring axis

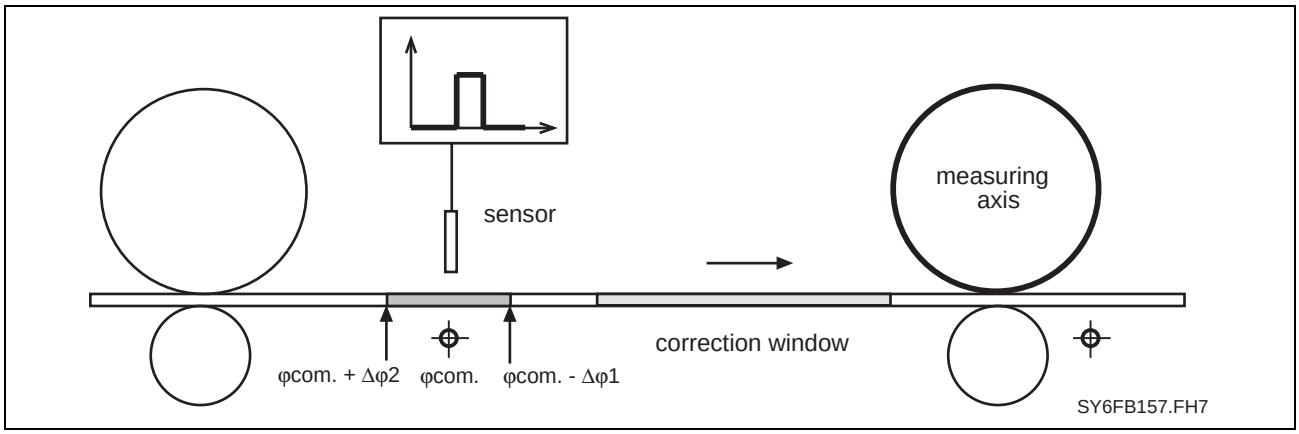


Fig. 7-12: Expectancy and correction windows

Register control - position command value

The "register control position command value" is the angle at which the measuring pulse is expected.

Expectancy window

The expectancy window is set in parameters "register control - negative limit expectancy window" ($\Delta\varphi 1$) and "register control - positive limit monitoring window" ($\Delta\varphi 2$). With these parameters, a window is fixed to the command value which automatically trails along with command value changes.

Any impulses occurring outside of this window are not taken into account.

Correction window

Control deviations are corrected within one parametrizable correction window.

The start and end of a correction can be alternately set as either absolute or relative. *Absolute* settings correspond to a permanent angle at the measuring axis. *Start of relative correction* means that the correction is conducted directly after the measured value is determined. *End of relative correction* means that the end of the correction is relative to its start.

The type of correction window is set in "process control - control word 1" (A-0-0025).

Several examples of alternate setting possibilities are outlined in the section "Parametrization", page 7-14.

7.3 Binary I/Os of the register control

Binary inputs

Designation	Function
_E:F#.18	process controller ON
_E:F#.19	process controller preset 1
_E:F#.20	process controller pause
_E:F#.35	process controller- setpoint lock
_E:F#.36	process controller preset 2

Fig. 7-13: Binary inputs of the register control

Activating the register control (_E:F#.18)

The register control is activated with binary input "process control ON".

Resetting the manipulated variable (_E:F#.19)

By setting input "process controller preset", the manipulated variable of the register control is cancelled with *indirect* correction.

The execution of the preset function is acknowledged with the output "process controller preset ack." (_A:F#.19).

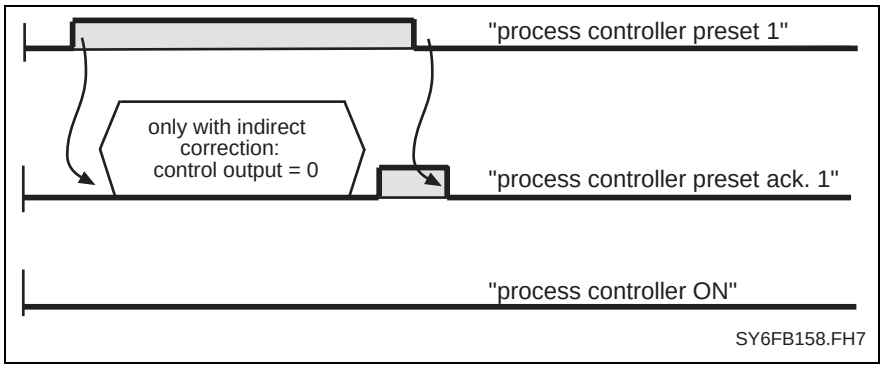

"process controller preset 1"
only with indirect correction: control output = 0
"process controller preset ack. 1"
"process controller ON"
SY6FB158.FH7

Fig. 7-14: Preset function with indirect register control

Note: This input is active with indirect correction only. The manipulated variable is automatically cancelled if the drive enable signal ("synchronization ON") is set when the register control is not active.

Process controller pause (_E:F#.20)

This input affects indirect register controller. The controller output is 'frozen' as long as the input is set.

Setpoint lock (_E:F#.35)

If this input is set, then the current position feedback value of the measuring axis is assumed as position command value for the register controller (A-0-0084) for this purpose.

Clearing test-values memory (_E:F#.36)

By setting input "Process controller preset 2", the test-values memory for the register controller with position measurement is cleared. This input is only effective if the register controller has been deactivated.

Binary outputs

Designation	Function
_A:F#.18	Process controller ON acknowledge
_A:F#.19	Process controller preset ack. 1
_A:F#.20	Process variable in process window
_A:F#.21	Min. process variable exceeded
_A:F#.22	Max. process variable exceeded
_A:F#.35	Process controller- setpoint lock acknowledge
_A:F#.36	Process controller preset acknowledge 2
_A:F#.37	Register control - mark failure

Fig. 7-15: Binary outputs of the register control

Process controller ON acknowledge (_A:F#.18)

The activation of the register control (_E:F#.18, "process controller ON") is acknowledged with this output.

Process controller preset acknowledge 1 (_A:F#.19)

Output "Process controller preset ack." acknowledges the cancelling of the manipulated variable ("Process controller preset ack.", _E:F#.19) of an indirect register control.

Process variable in process window (_A:F#.20)

Parameter "Register control - maximum correction" (A-0-0106) can be used to limit the manipulated variable of the register control. As long as the measured deviation does not exceed this limit, output _A:F#.20 is set.

Minimum/maximum process variable exceeded (_A:F#.21/22)

With indirect register control the controller output is limited by "Indirect register control - positive control output limit" (A-0-0122) or "Indirect register control - negative control output limit" (A-0-0123). "Minimum/maximum process variable exceeded" is set, if a limit is reached.

Process controller preset acknowledge 2 (_A:F#.36)

This output acknowledges that the test-values memory has been cleared.

Register control - mark loss (_A:F#.37)

This output is set, if more consecutive mark are missing than are permitted in parameter "Register control - max. mark losses" (A-0-0127).

7.4 Insetting control

If pre-printed material is being processed, then individual processing stations must be able to align themselves to this prepared product. An example is the printing of address fields on a sheet. This process is called insetting.

For register control, this means that there must be a "latching into place" on a preprinted register mark. Such a procedure is needed, for example,

- after the web has been pulled in and
- after the flying change of a roll of paper.

A single function that makes an automatic latching onto pre-printed register marks possible is not available on the CLC control. The latching procedure can, however, be coordinated with the help of a small number of parameters and the binary output of the register control, e.g., from a higher-ranking PLC.

Locking the register control

After a new web has been pulled in or after a roll has been changed, the position of the product in terms of the processing station is coincidental. This means that the pulse of the marker detection can be located outside of the expectancy window so that no marker can be detected or correction executed.

The following procedure enables a locking of the register control without requiring any steps by the operator, e.g., the manual setting up of a sensor.

For the measuring pulses to be reliably detected, it is necessary to range the expectancy window as broad as possible (e.g.,+/- 178°). The correction variable limit, i.e., the maximum movement, can be increased to accelerate the locking process.

The sequence of such a locking process is described in the following text.

As long as the limiting of the correction variable remains effective, the direction of the correction of one of the outputs "min./max. process variable exceeded" (_A:F#.21 or 22) is set (compare with binary outputs). The maximum permissible variable movement is executed after each measuring pulse. The axis is thereby aligned to the register mark. As soon as the correction variable or the correction path is situated within the permissible range, the output "min./max. process variable exceeded" (_A:F#.21 or 22) is cleared. The locking procedure is thus completed.

When monitoring the measuring process during production, it is necessary to shrink the size of the expectancy window.

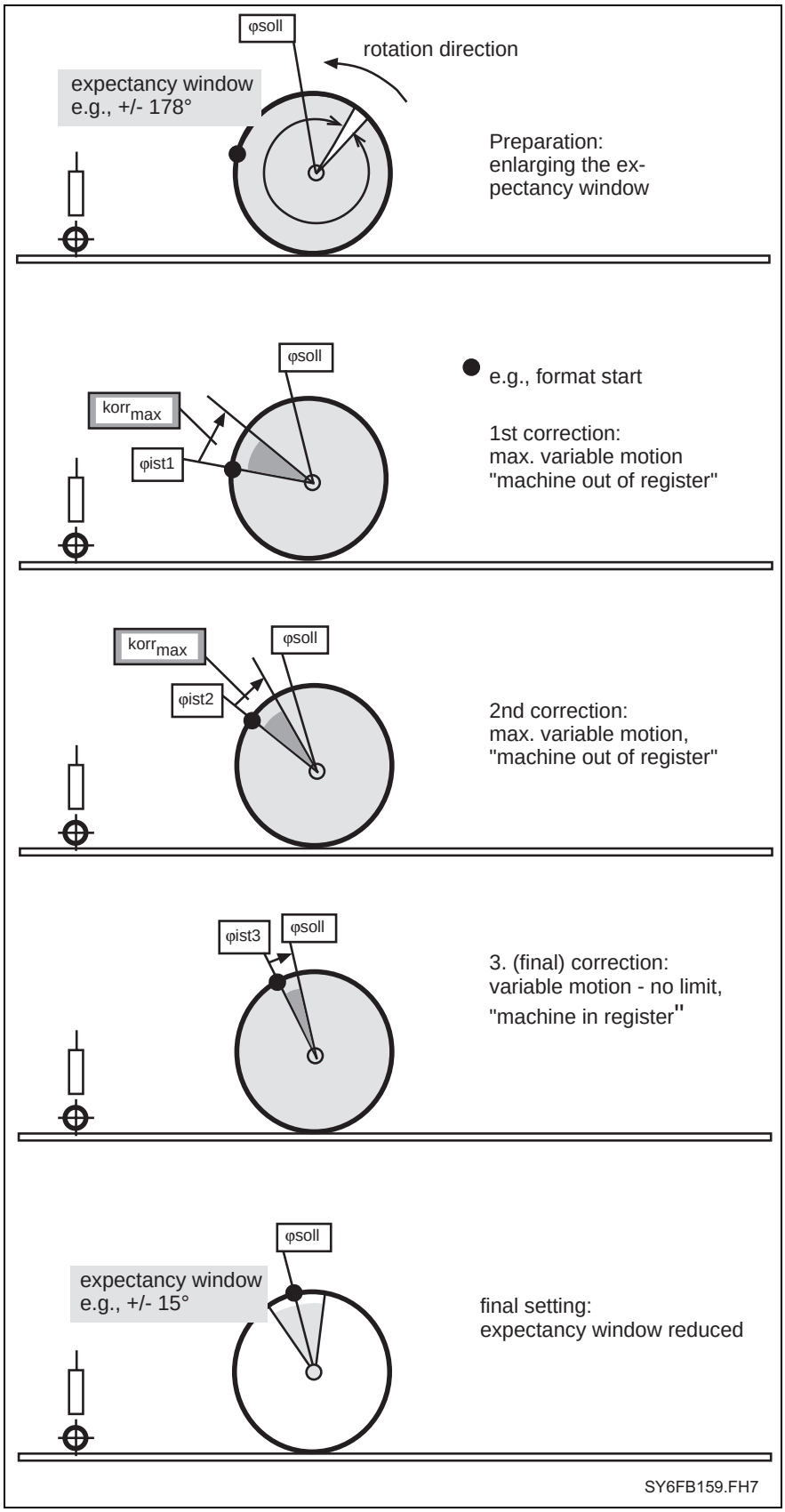


Fig. 7-16: Example of a locking procedure with insetting control

7.5 Project planning notes

The number of register controls is limited CLC internally to ten. Theoretically, ten direct or indirect register controls can be configured for *one* CLC control board. Each of the activated controllers can affect up to four axes. The actual permissible number of register controls that can be activated depends on the cycle time within the SYNAX ring and the maximum machine speed.

Cycle times

The register control belongs to the real-time functions on the CLC control board. Real-time functions are processed cyclically as part of the system clock. The real-time function "register control" is executed only *once* per cycle. This means that in the case of three register controls, for example, each one is processed once every three cycles.

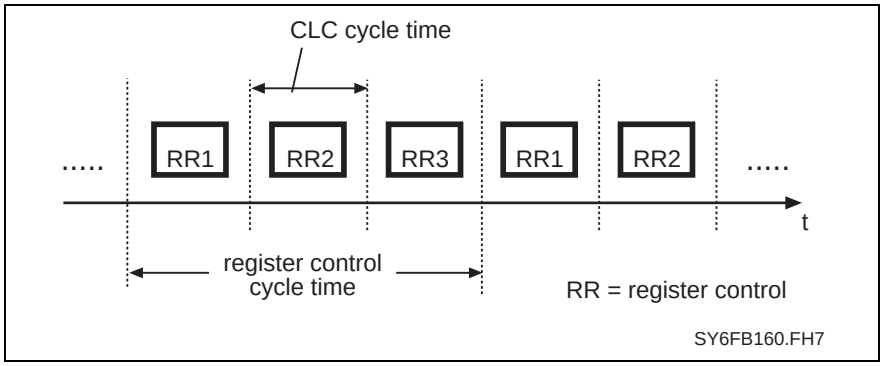


Fig. 7-17: Processing cycle of the register control

Register control cycle time

The cycle time of the CLC T_{CLC} is fixed by the communications cycle in the SYNAX ring ("SERCOS cycle time" (S-0-0002)). The register control cycle time T_{RR} is dervied from:

$$T_{RR} = n_{RR} * T_{CLC}$$

T_{RR}: register control cycle time in [ms]
n_{RR}: number of activated register controls
T_{CLC}: CLC cycle time (S-0-0002) in [ms]

Fig. 7-18: Register control cycle time

System limits

The interplay of internal functional processes between register control and measured value detection in the drive requires that the register control is run through five times with each master axis rotation. The maximum number of register controls is thereby limited and depends on the CLC cycle time and the master axis speed.

Maximum master axis speed

The maximum permissible master axis speed with a given number of register controls can be calculated as follows:

$$v_{Lmax} = 60*10^3 / (5 * T_{RR})$$

T_{RR}: register control cycle time in [ms]
v_{Lmax}: maximum legal master axis speed in in [rpm]

Fig. 7-19: Maximum master axis speed

Example:

CLC cycle time T_{CLC} = 4 ms

Projected register control: 6

⇒ Register control cycle time T_{RR} = 6 * 4 = 24 ms

⇒ Maximum master axis speed $\mathbf{v_{Lmax}}$ = 60000 / (5 * 24) **= 500 rpm**

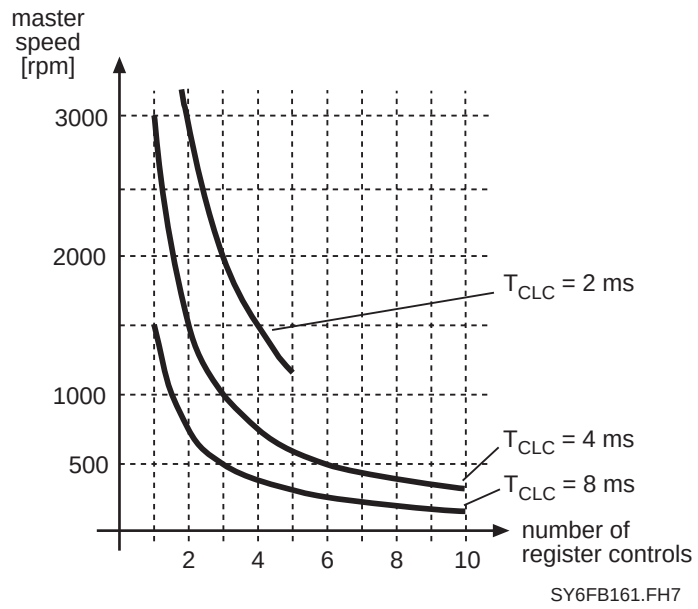


Fig. 7-20: Maximum master axis speed

Number of register controls that can be activated

The maximum permissible number of register controls with a given master axis speed can be determined as follows:

$$n_{RRmax} = 60*10^3 / (5 * T_{CLC} * v_L)$$

T_{CLC}: CLC cycle time (S-0-0002) in [ms]
v_L: permissible master axis speed in [rpm]

Fig. 7-21: Maximum number of register controls that can be activated

Example:

CLC cycle time T_{CLC} = 4 ms

Master axis speed v_L = 1000 rpm

⇒ Register controls active $\mathbf{n_{RRmax}}$ = 60000 / (5 * 4 * 1000) **= 3**

Note: The number of register controls that can be activated is internally limited by the CLC to ten.

Expansion capabilities

The register control cycle time can be halved. There is a setting in the "process control - control word 1" (A-0-0025) for this purpose.

Two register controls are calculated per each CLC cycle. This achieves higher master axis speeds or a greater number of register controls can be activated.

Generally, in those plants with "numerous" register controls, the use of the CLC link should be taken into account.

7.6 Parametrization

Settings at the measuring axis

Type of axis

The measuring axis must be a modulo axis.

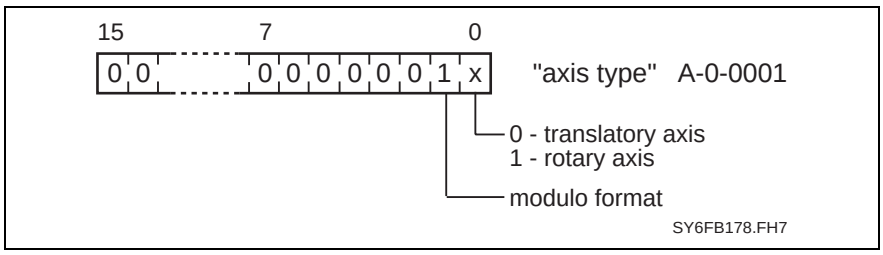


Fig. 7-22: Axis type of the measuring axis

Synchronization type

The measuring axis for the register control can only be a following axis in "synchronization mode". Each operating mode

- phase synchronization,
- speed synchronization or
- electronic cam

is permissible (parameter "synchronization mode" (A-0-0003)).

Allocating measuring axis - regulated axis/axes

One register control can affect up to four axes. The allocation is fixed in parameter

"process control - drive addresses" (A-0-0087).

The addresses of all the axes are entered here in the form of a list. These are the axes that are to effect the register control.

Selecting the measured variable

The measured variable is selected in "process control - control word 1" (A-0-0025):

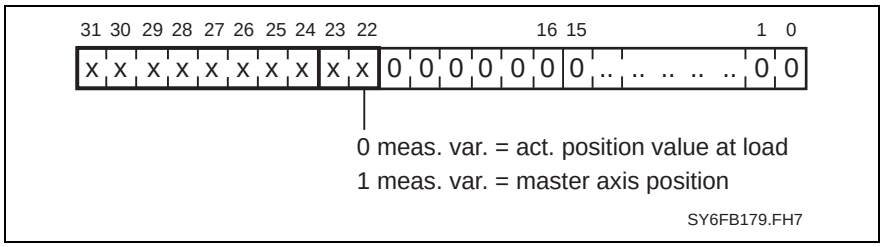

31 30 29 28 27 26 25 24 23 22 16 15 1 0
x x x x x x x x x x 0 0 0 0 0 0 0 .. .. 0 0
0 meas. var. = act. position value at load
1 meas. var. = master axis position
SY6FB179.FH7

Fig. 7-23: Measured variable for detecting the markers

Arranging the sensor

In the simplest case, the measuring axis is a format cylinder (= regulated axis) and the distance of the sensor to the measuring axis is less than the format length. Measurement and correction relate to the *same* product.

Frequently it is necessary to mount the mark sensor further away from the measuring axis, e.g., hazardous areas in printing facilities. If the distance is greater than the format, then the measured register error cannot be corrected until the product has reached the format cylinder. The correction must be delayed by as many product cycles as there are formats between the regulated axis and the sensor.

The delay of the correction is implemented by a shift register function on the CLC. The correction values are entered in a test-values memory and fed to the controller using a parametrizable number of product cycles, in a delayed manner.

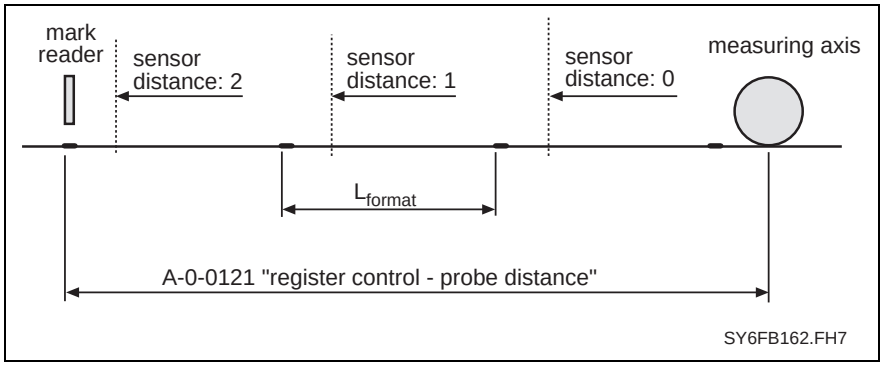


Fig. 7-24: Register control probe distance

The pulse cycles of the shift register are entered in parameter "register control - probe distance" (A-0-0121). It applies:

0 < sensor distance < L_{format} : A-0-0121 = 0

L_{format} < sensor distance < 2 * L_{format} : A-0-0121 = 1

2 * L_{format} < sensor distance < 3 * L_{format} : A-0-0121 = 2 and so on.

The test-value memory can accept a maximum amount of 30 values, i.e., the distance between mark sensor and regulated axis may not equal more than 30 format lengths.

The shift register can be cleared via binary input "process controller preset 2" (_E:F#.36).

Gating register marks

If control is to use only every n^{th} mark, then the invalid marks can be suppressed. Which mark is to be used for the control operation is set in parameter

"Register control - mark gating" (A-0-0129).

Example: (see Fig.):

Every third register mark is valid ⇒ A-0-0129 = 3

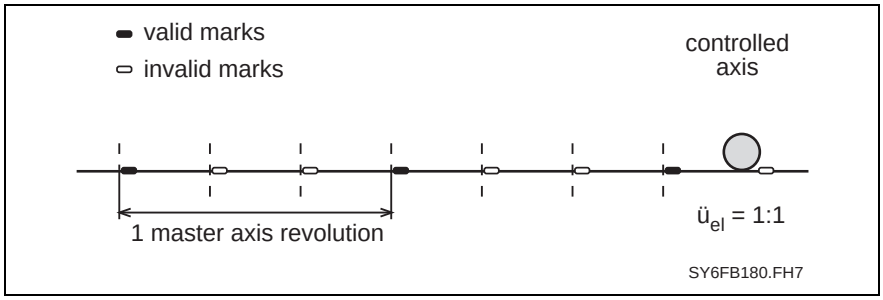


Fig. 7-25: Gating marks

Setting the valid mark:

Jog register mark under sensor. By setting binary input "process controller - command lock", the current position is assumed by the register controller as the current position.

If sensor distance > 1 (A-0-0121) has been parametrized, then the measured value memory must be simultaneously deleted via "Process control preset 2".

Sensor delay time compensation

Delay times between recognition of register mark and edge of the measuring signal at sensor output result in a measuring error when detecting position at the measuring axis. The measuring error results in a speed-dependent register error.

If the delay time of the sensor is entered in parameter

"Register control - probe delay time compensation" (A-0-0128),

then the measured error will be taken into consideration when generating the correction angle.

Position command value

The position command value for the register control is the angle referencing the measuring axis which is to be measured, e.g., the edge of an optical sensor. The command value can be set in parameter

"register control - position command" (A-0-0084).

If bit 21 is set in "Process controller - control word 1" (A-0-0025), then the position command value for the register controller can be changed via the CLC jog function.

Setting the expectancy window

The expectancy window is the angle range as relates to the measuring axis in which the measurement is to take place, i.e., in which a register marker is to be detected. The expectancy window trails the command value. This is accomplished with the help of two parameters, viz.,

"register control - negative limit monitoring window" (A-0-0088) and

"register control - positive limit monitoring window" (A-0-0089)

When setting, the rotational direction of the measuring axis must reference the master axis:

Note: "Register control - negative limit monitoring window" (A-0-0088) is defined as *counterclockwise*, "register control - positive limit monitoring window" (A-0-0089) is *clockwise*, in terms of the master axis.

Clockwise rotation of the expectancy window

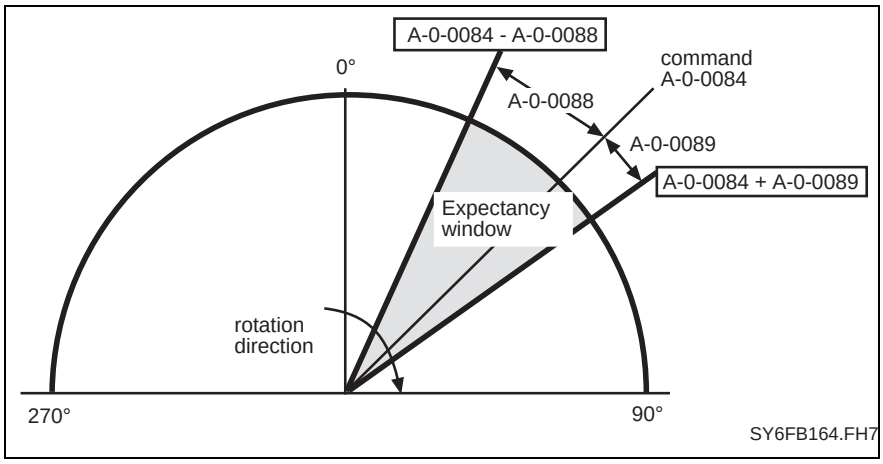


Fig. 7-26: Positive rotational direction of a the expectancy window

Example:

command value A-0-0084 = 45°

expectancy window = 15° ... 55°

⇒ "register control - negative limit monitoring window" (A-0-0088) = 30°

"register control - positive limit monitoring window" (A-0-0089) = 10°

Counterclockwise rotational direction of expectancy window

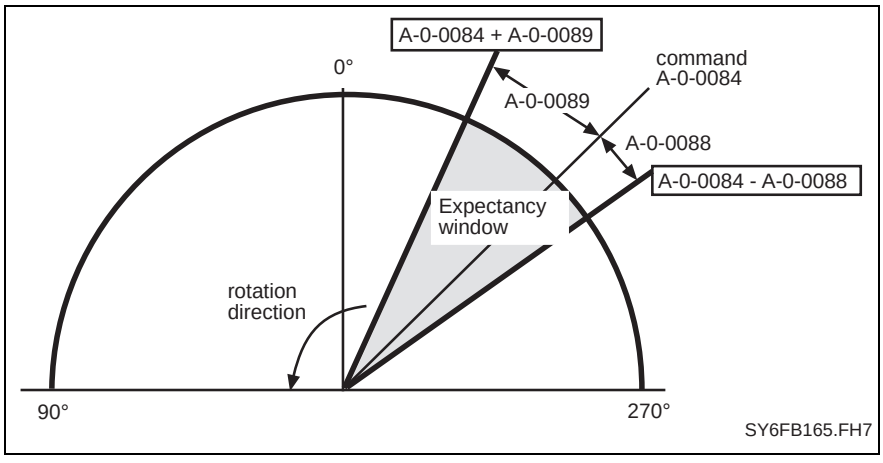


Fig. 7-27: Negative rotational direction of the expectancy window

Example:

Command value A-0-0084 = 315°

Expectancy window = 305° ... 335°

⇒ "register control - negative limit monitoring window" (A-0-0088) = 10°

"register control - positive limit monitoring window" (A-0-0089) = 20°

Monitoring register marks

As long as register marks are detected in the expectance window, output "Register control - mark failure" (_A:F#.37) will be cleared.

A mark failure sets the output. A mark failure is given if more sequential marks fail than are permitted in parameter "register control - max. register mark losses" (A-0-0127).

Limiting the manipulated variable

A limit value can be set with *direct correction* at the controlled axis in parameter

"register control - maximum correction" (A-0-0106).

Parameter A-0-0106 is set at the measuring axis and affects all axes allocated to the register control. The limit works at the control input, i.e., the control deviation is limited to the value parametrized in A-0-0106.

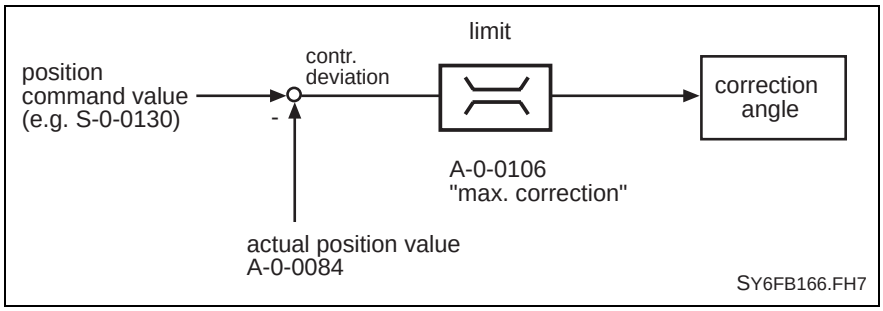


Fig. 7-28: Limiting the manipulated variable with position measurement

Note:	If control deviation is specified by an external register control, then the limit effects control deviation.

With *indirect* correction, the controller output can be limited by

"indirect register control - positive control output limit" (A-0-0122),

"indirect register control - negative control output limit" (A-0-0123).

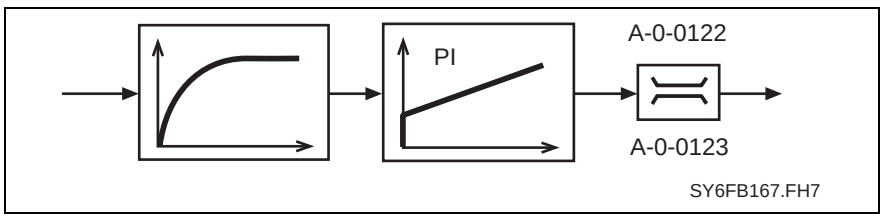


Fig. 7-29: Limiting indirect register controller

Dead Band

With the help of parameter "register control - dead band" (A-0-0074) it is possible to freeze the controller output with small register errors.

If the measured register deviation is smaller than the parametrized value, the only 1/16 of the measured value is used for the control. With indirect control the P gain is also not taken into account.

Processing cycles with multiple register controls

If multiple register controls are worked with in one SYNAX ring, then it may be necessary to reduce the CLC internal cycle times for the register control. This is done with the help of bit 23 in "process control - control word 1" (A-0-0025).

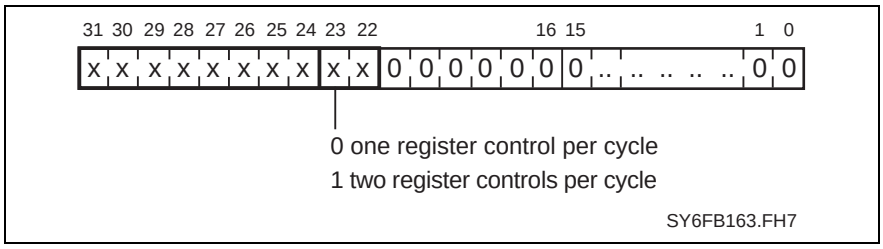

31 30 29 28 27 26 25 24 23 22 16 15 1 0
x x x x x x x x x x 0 0 0 0 0 0 0 .. .. 0 0
0 one register control per cycle
1 two register controls per cycle
SY6FB163.FH7

Fig. 7-30: Cycle time for the register control

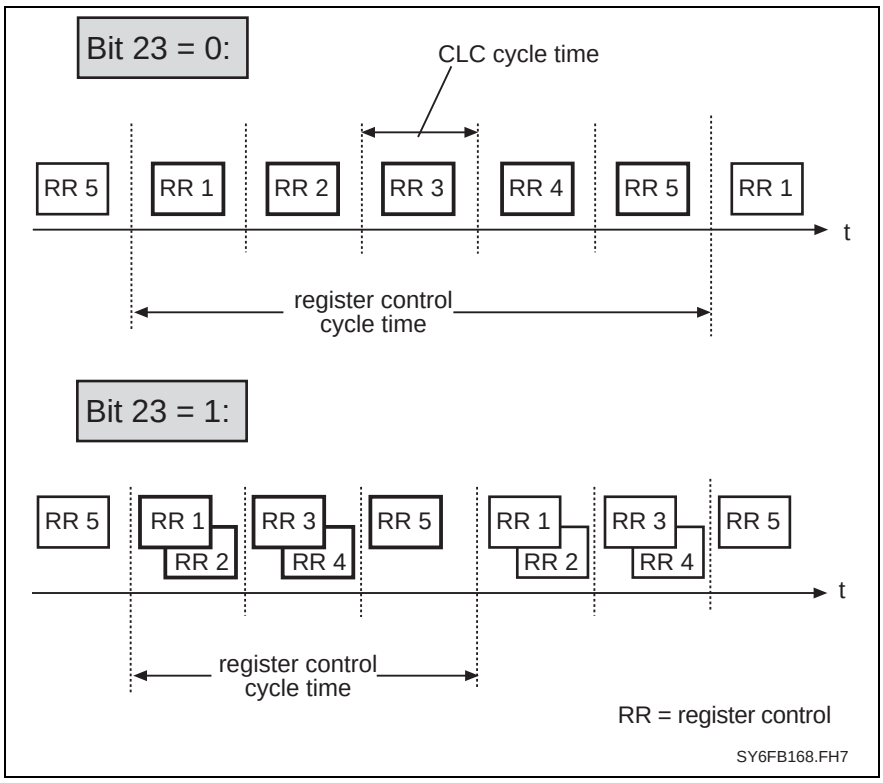


Fig. 7-31: Double processing speeds with five register controls

Note: It suffices to set bit 23 in *one* of the configured measuring axes.

Settings at the controlled axis

Type of axis

No special type of axis is prescribed for controlled axes.

Synchronization Mode

Each of the operating modes phase synchronization, speed synchronization or electronic cam is permissible (parameter "synchronization mode" (A-0-0003)).

Synchronization mode

"Synchronization with position command value filter" must be set in controlled axis. The "additive position command value" generated by the register control is fed to the position controller in the drive via a PT1 filter.

"Synchronization with position command filter" is selected in parameter "synchronization mode",

P-0-0155 = 1

The time constant of the PT1 filter is set in parameter "filter time constant additional position command" (P-0-0060).

Controlling several following axes

The electronic transmission ratio must be correctly set, i.e., with the register control deactivated, the drives **must** be synchronous to each other. Faulty parametrization, e.g., an incorrectly set format, cannot be compensated for by the register control.

Effective manipulated variables

Depending on the synchronization mode which has been activated, the register controller can affect various parameters.

The effective manipulated variable is selected in parameter

"register control - target parameter selection" (A-0-0107).

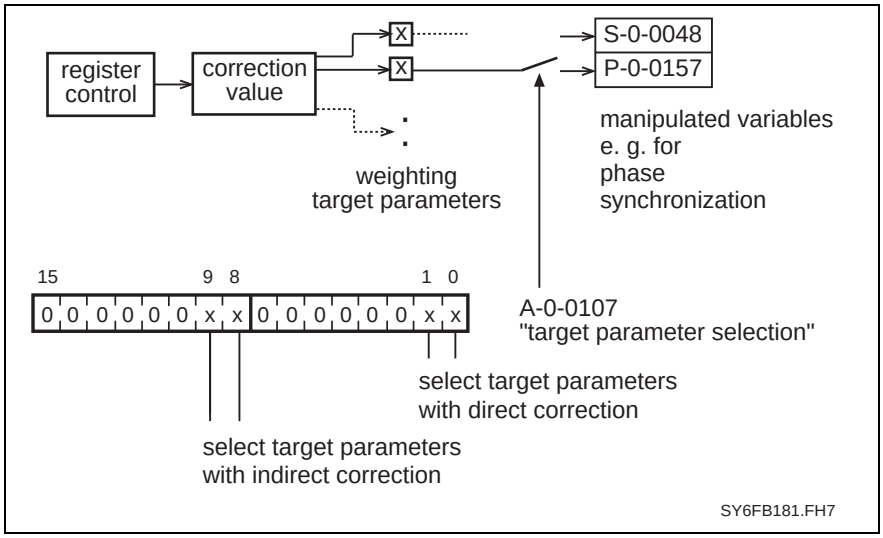


Fig. 7-32: Selecting the target parameters

Target parameters with direct correction

A-0-0107 Bit 1 - 0	Phase synchronization	Speed synchronization	Electronic cam
0 0	position command value additional (S-0-0048)	additive velocity command value (S-0-0037)	phase offset begin of profile (P-0-0061)
0 1	---	gain adjust (P-0-0083)	position command value additional (S-0-0048)
1 0	---	---	cam shaft distance (P-0-0093)
1 1	"master drive gear output rev." (P-0-0157)	"master drive gear output rev." (P-0-0157)	"master drive gear output rev." (P-0-0157)

Fig. 7-33: target parameters with direct correction

Target parameters with indirect correction

A-0-0107 Bit 9 - 8	Phase synchronization	Speed synchronization	Electronic cam
0 0	position command value additional (S-0-0048)	gain adjust (P-0-0083)	phase offset begin of profile (P-0-0061)
0 1	---	additive velocity command value (S-0-0037)	position command value additional (S-0-0048)
1 0	---	---	cam shaft distance (P-0-0093)
1 1	"master drive gear output rev." (P-0-0157)	"master drive gear output rev." (P-0-0157)	"master drive gear output rev." (P-0-0157)

Fig. 7-34: target parameters with indirect correction

Effective variable The effective variable is usually generated from the preset value (A parameters) and the controller output.

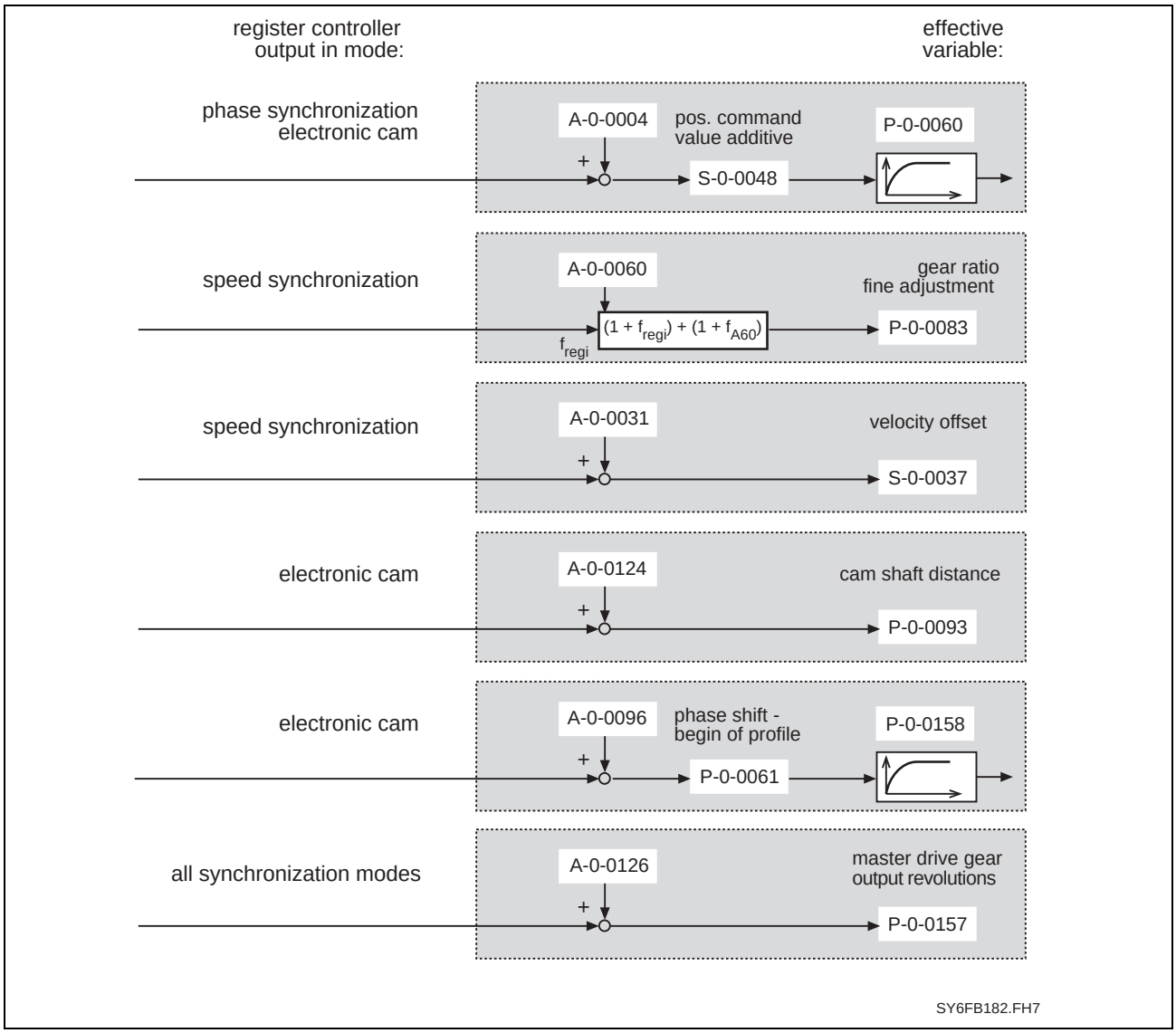


Fig. 7-35: Effective variables

Notes on parametrization:

- If a direct register controller affects „position command additional value“ or "phase offset begin of profile', then angle correction must be performed within a specified window. Filter time constants P-0-0060 or P-0-0158 should not exceed 20 ms.
- If the register controller affects "master drive gear output revolutions", then the gear ratio between master axis and regulated axis is affected. To achieve sufficient resolution, enter value, e.g., 1000, into parameters "master drive gear output revolutions" (A-0-0126) and "master drive gear input revolutions (P-0-0156).

Target parameters weighting with direct control

The manipulated variable can be weighted for each of the axes assigned to the register control.

Weighting is set in parameter

"direct register control - correction value weighting" (A-0-0105).

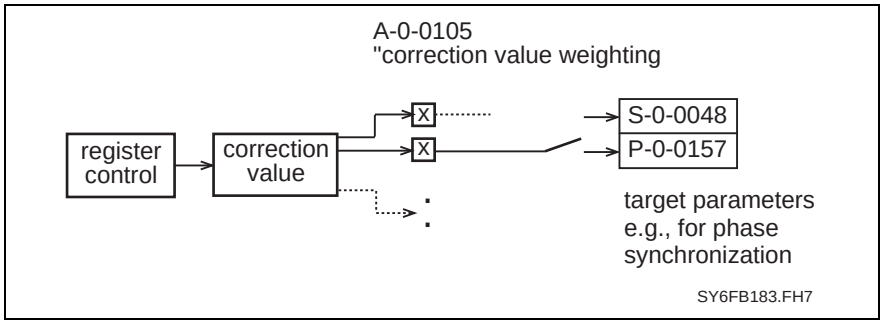


Fig. 7-36: Correction value weighting

Direct correction with position measurement

"Process control - control word 1" (A-0-0025)

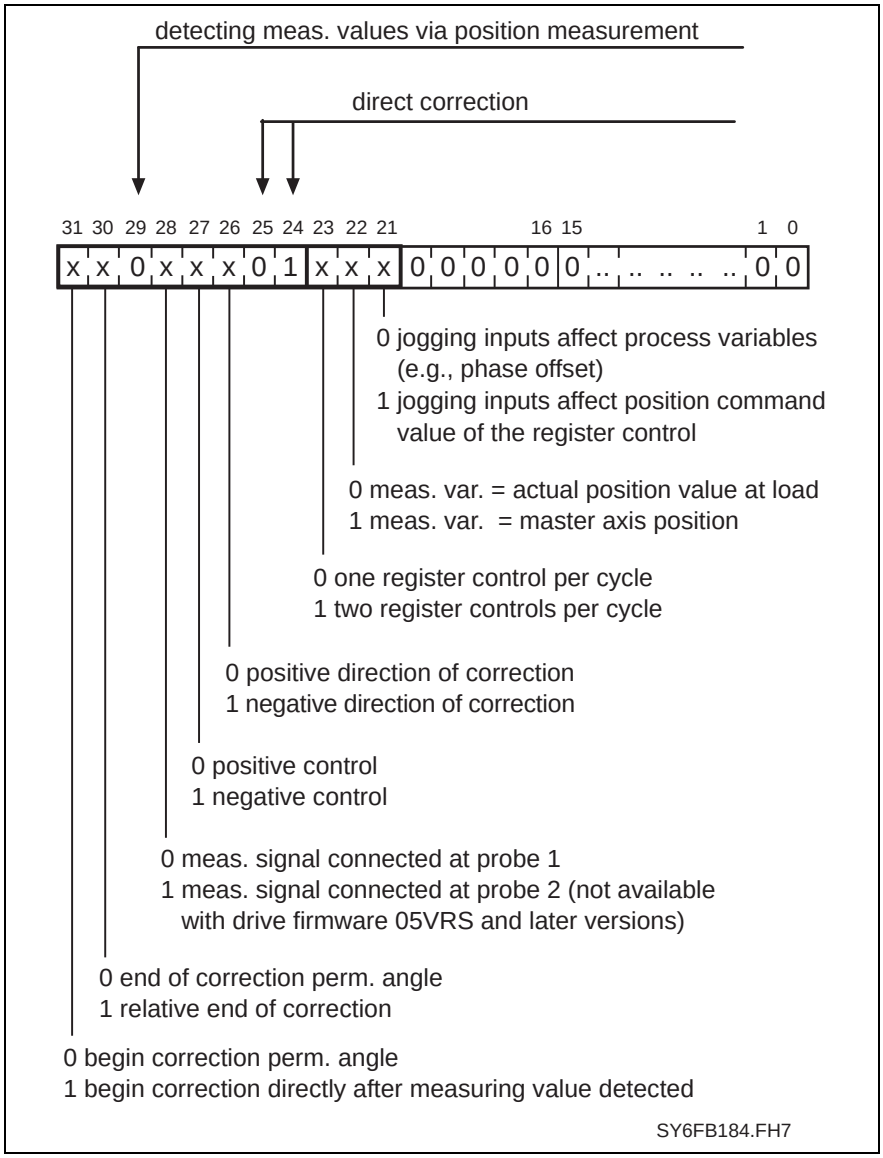

detecting meas. values via position measurement
direct correction
31 30 29 28 27 26 25 24 23 22 21 16 15 1 0
x x 0 x x x 0 1 x x x 0 0 0 0 0 0 .. .. 0 0
0 jogging inputs affect process variables (e.g., phase offset)
1 jogging inputs affect position command value of the register control
0 meas. var. = actual position value at load
1 meas. var. = master axis position
0 one register control per cycle
1 two register controls per cycle
0 positive direction of correction
1 negative direction of correction
0 positive control
1 negative control
0 meas. signal connected at probe 1
1 meas. signal connected at probe 2 (not available with drive firmware 05VRS and later versions)
0 end of correction perm. angle
1 relative end of correction
0 begin correction perm. angle
1 begin correction directly after measuring value detected
SY6FB184.FH7

Fig. 7-37: Process control control word with direct correction/position measurement

Setting the correction window

The correction window is an angle range relating to the measuring axis. A direct register control regulates the control deviations within this window. Position and size of the correction window are *set at the measuring axis* with the help of the following parameters.

"Process control - control word 1"	(A-0-0025)
"register control - start of correction angle"	(A-0-0085)
"register control - end of correction angle"	(A-0-0086)

When setting the correction window, the electronic transmission ratio must be taken into account.

Permanent correction window

The position of the correction window is permanent, i.e., start and end of correction are constant angles.

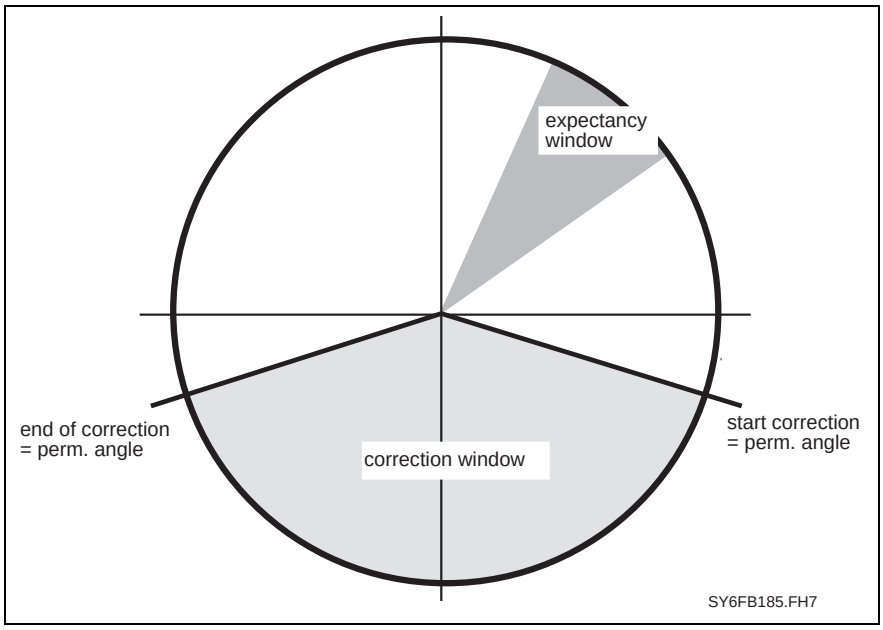


Fig. 7-38: Permanent correction window

Start of correction directly after measured value detection, end of correction relative

The start of correction is the same as the actual position value of the measuring axis with measured value detection. The end of correction is always at a permanent angular distance behind the start of the correction.

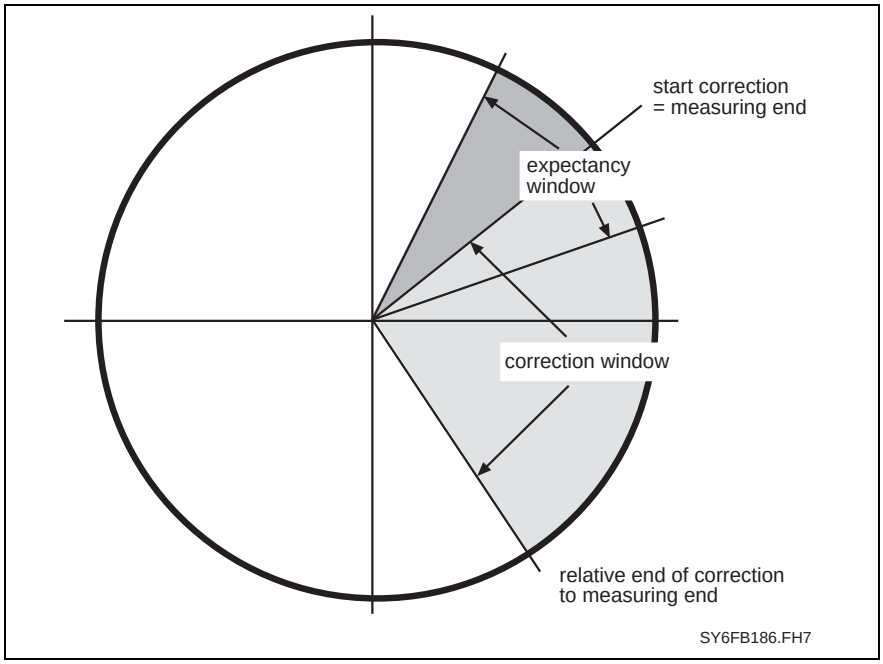


Fig. 7-39: Relative correction window with permanent window width

Correction start directly after measured value detection, end of correction absolute

The start of correction is the same as the actual position value of the measuing axis with measured value detection. The end of the correction is set at a permanent angle.

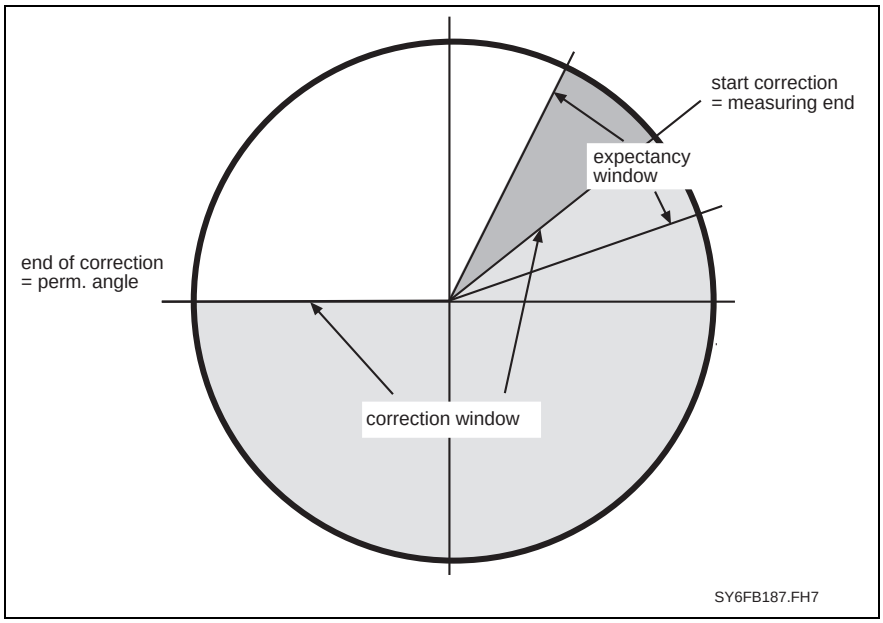


Fig. 7-40: Relative correction window with permanent end of correction

Examples of permanent correction windows

Note: "Register control - start of correction angle" (A-0-0085) may not be situated within the expectancy window. A faulty parametrization of this can cause unwanted axis movements!

Electronic gear ratio 1:1

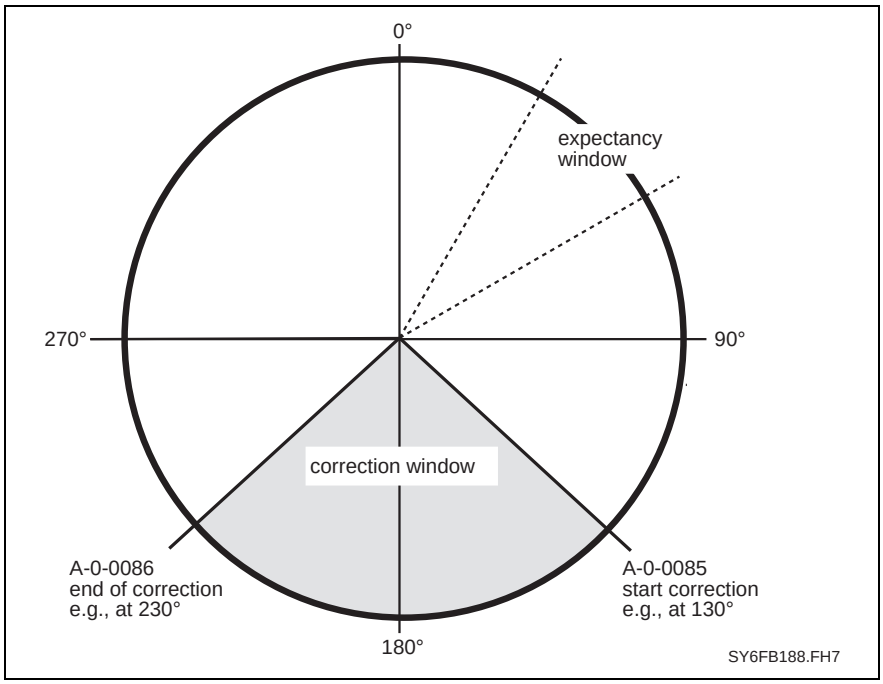


Fig. 7-41: Permanent correction window, example 1

Electronic gear ratio 4:1

If an electronic ratio not equal to 1:1 is set for the measuring axis (parameters S-0-0236 and S-0-0237), then the start and end of correction must be appropriately recalculated:

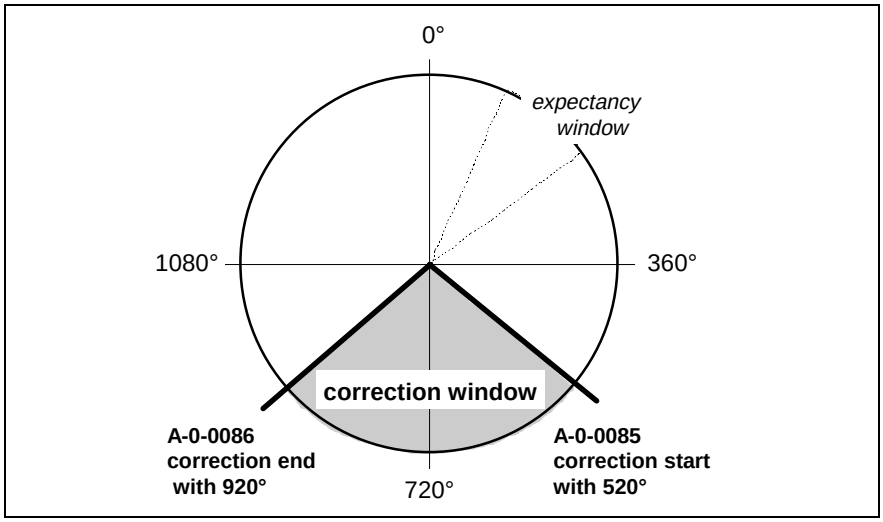


Fig. 7-42: Permanent correction window, example 2

Example of a relative correction window with permanent window width

(electronic gear ratio 1:1)

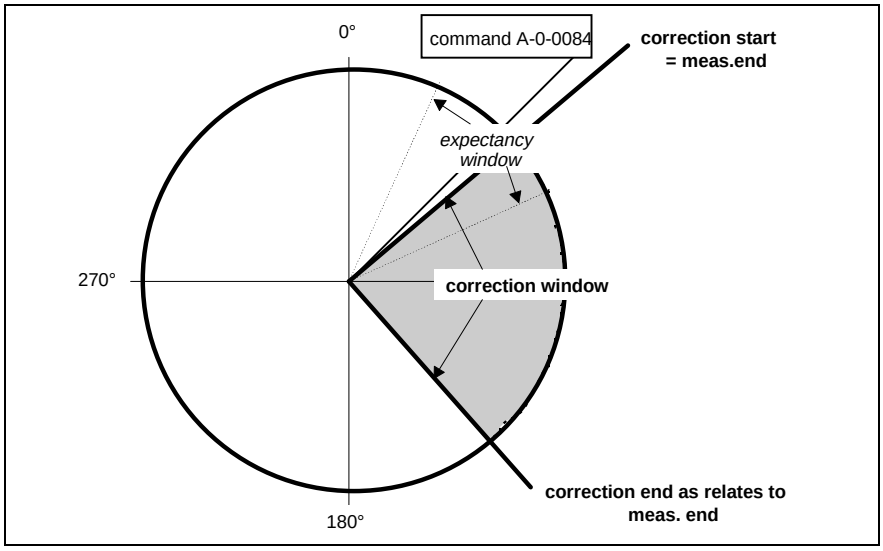


Fig. 7-43: Relative correction window, window width = constant

The width of the correction window should equals, e.g., 90°:

⇒ "Register control - start of correction angle" (A-0-0085) = 0°

"Register control - end of correction angle" (A-0-0086) = 90°

If measuring should take place at 51°, for example, then the correction will be conducted in the range of 51° ... 141°.

Example of relative correction window with permanent correction end

(electronic gear ratio 1:1)

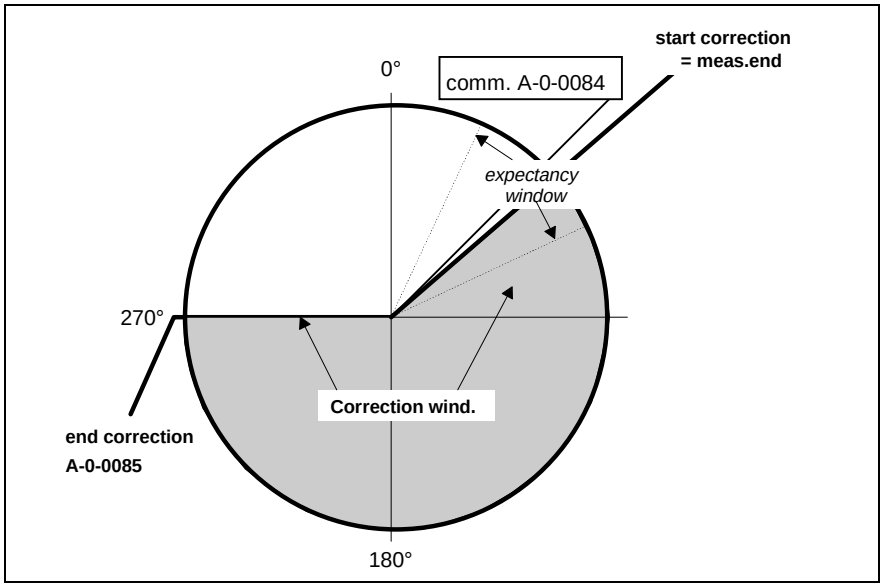


Fig. 7-44: Relative correction window, end correction = absolute angle

The correction should be concluded at 270°:

⇒ "Register control - start of correction angle" (A-0-0085) = 0°

"Register control - end of correction angle" (A-0-0086) = 270°

Indirect correction with position measurement

"Process control - control word 1" (A-0-0025)

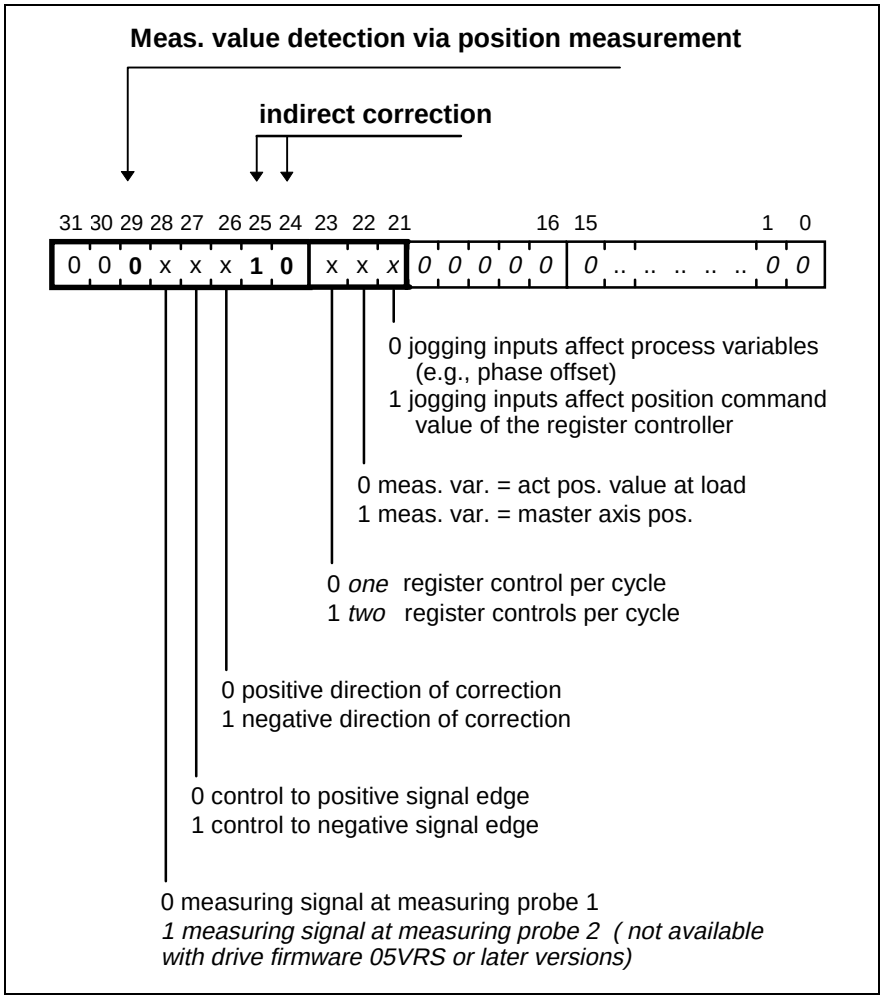

Meas. value detection via position measurement
indirect correction
31 30 29 28 27 26 25 24 23 22 21 16 15 1 0
0 0 0 x x x 1 0 x x x 0 0 0 0 0 0 .. .. 0 0
0 jogging inputs affect process variables (e.g., phase offset)
1 jogging inputs affect position command value of the register controller
0 meas. var. = act pos. value at load
1 meas. var. = master axis pos.
0 one register control per cycle
1 two register controls per cycle
0 positive direction of correction
1 negative direction of correction
0 control to positive signal edge
1 control to negative signal edge
0 measuring signal at measuring probe 1
1 measuring signal at measuring probe 2 (not available with drive firmware 05VRS or later versions)

Fig. 7-45: Process control - control word with indirect correction with pos. meas.

Controller settings

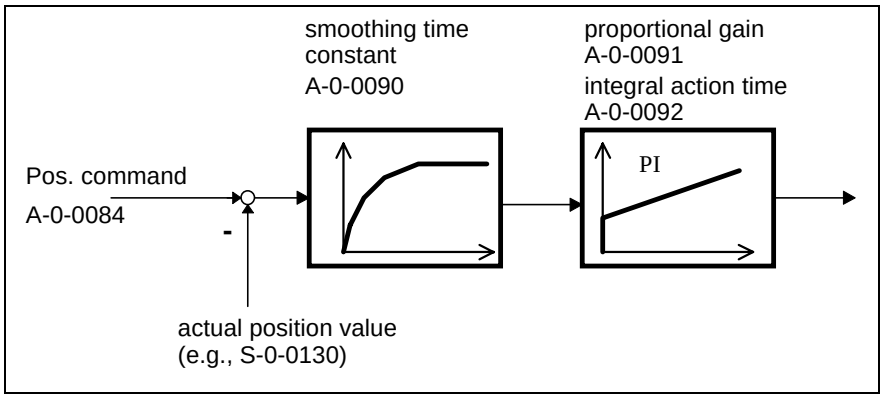


Fig. 7-46: Parameter of the indirect register control

Direct correction with time measurement

"Process control - control word 1" (A-0-0025)

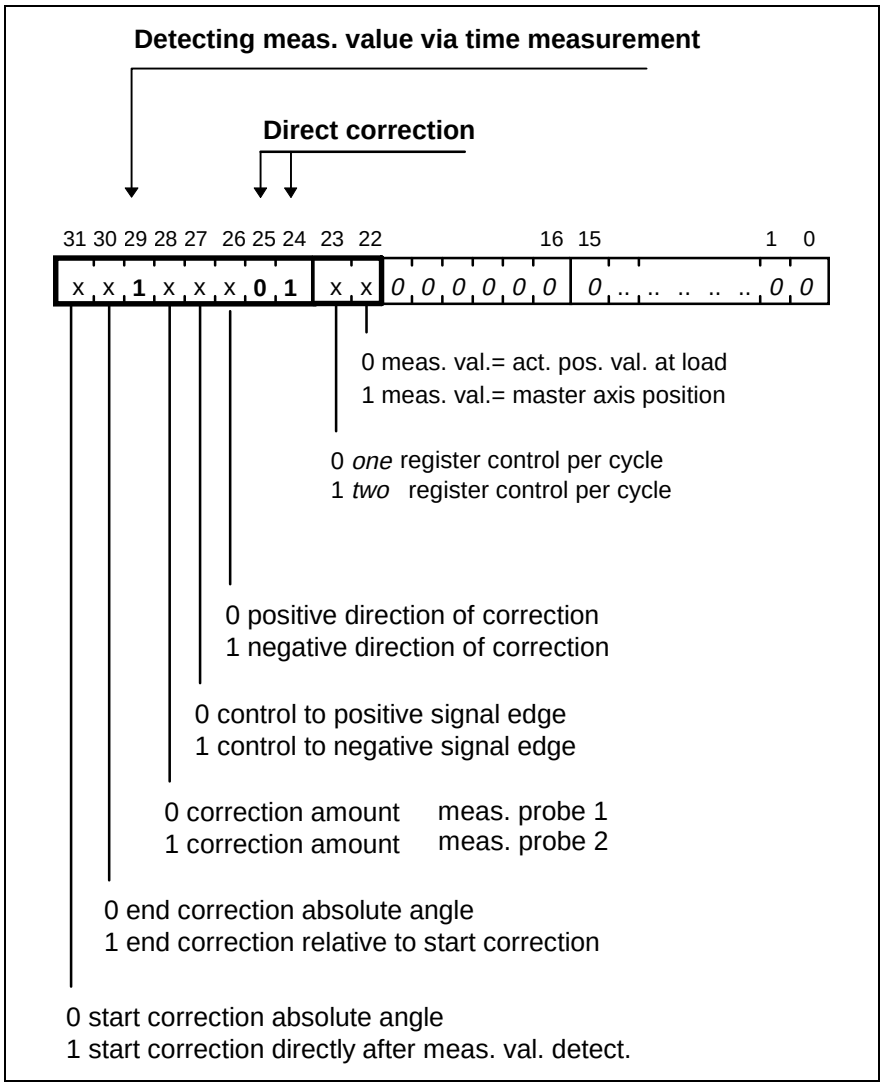

Detecting meas. value via time measurement
Direct correction
31 30 29 28 27 26 25 24 23 22 16 15 1 0
x x 1 x x x 0 1 x x 0 0 0 0 0 0 0 .. .. 0 0
0 meas. val.= act. pos. val. at load
1 meas. val.= master axis position
0 one register control per cycle
1 two register control per cycle
0 positive direction of correction
1 negative direction of correction
0 control to positive signal edge
1 control to negative signal edge
0 correction amount meas. probe 1
1 correction amount meas. probe 2
0 end correction absolute angle
1 end correction relative to start correction
0 start correction absolute angle
1 start correction directly after meas. val. detect.

Fig. 7-47: Process control - control word with direction with time measurement

Assigning the measuring probe inputs

Bit 28 in "process control - control word 1" (A-0-0025) sets the assignment of the measuring probe inputs.

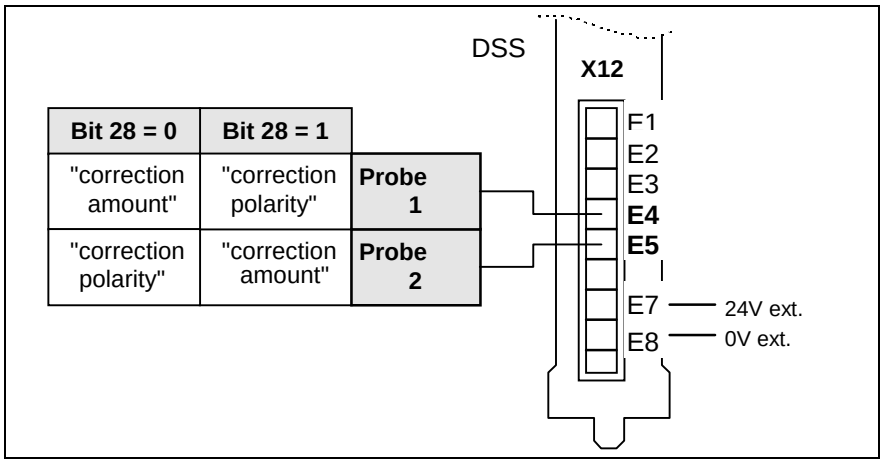


Fig. 7-48: Correction signal adjustments

Controller output polarity

The signal "correction polarity" determines the qualifying symbol of the path of correction. Bit 26 in "process control - control word 1" (A-0-0025) fixes which polarity is specified by the level of this input.

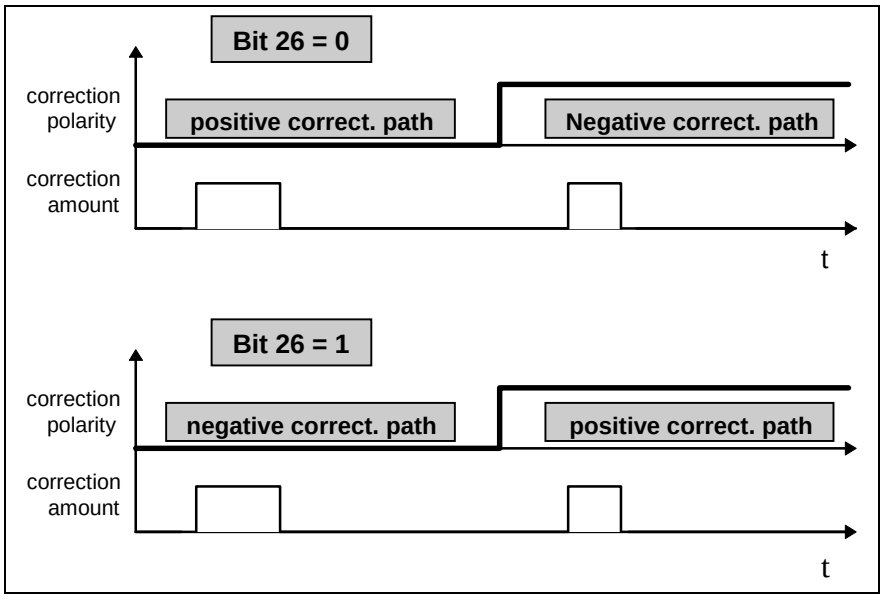


Fig. 7-49: Polarity with register control with time measurement

Effective signal edge

The signal "correction amount" specifies the amount of the correction path. This signal can be active at either a LOW or HIGH level.

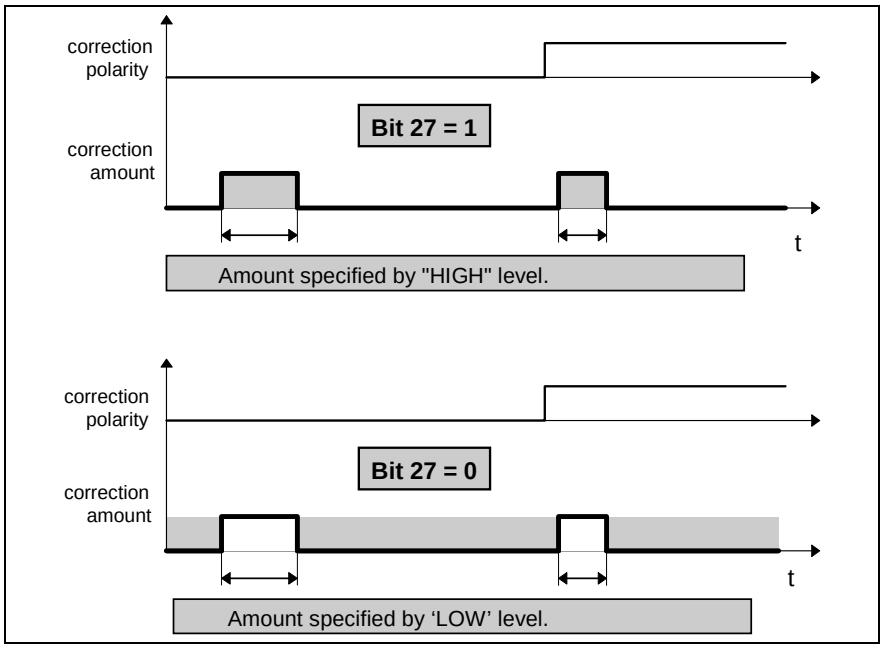


Fig. 7-50: Effective signal edge with register control with time measurement

The voltage time area corresponding to the correction path has a grey background.

Configuration examples:

- Probe 1 of the DSS is used for the correction signal "correction amount, probe 2" for the signal "correction polarity".

⇒ **Bit 28 = 0**

- A HIGH level of the signal "correction polarity" sets a negative correction direction (negative correction value).

⇒ **Bit 26 = 0**

- A HIGH level of signal "correction amount" sets the correction value, i.e., the measured value is latched to the negative edge.

Bit 27 = 1

- The correction window is set to a permanent angle (correction start and end).

⇒ **Bit 30 = 0, bit 31 = 0**

Settings in "process control - control word 1":

A-0-0025 = 0010 1001 00*00 0000 0000 0000 0000 0000*

= 0 x 2 9 0 0 0 0 0 0

Weighting the correction signal

In the case of "register control with time measurement", the correction angle of an external register control is calculated and specified as a pulse-width modulated signal. The weighting for the signal "correction amount" is set in parameter

"register control - time measureing weighting" (A-0-0098).

Setting the correction window

(As with direct correction with position measurement.)

Block diagram

Direct correction with position measurement

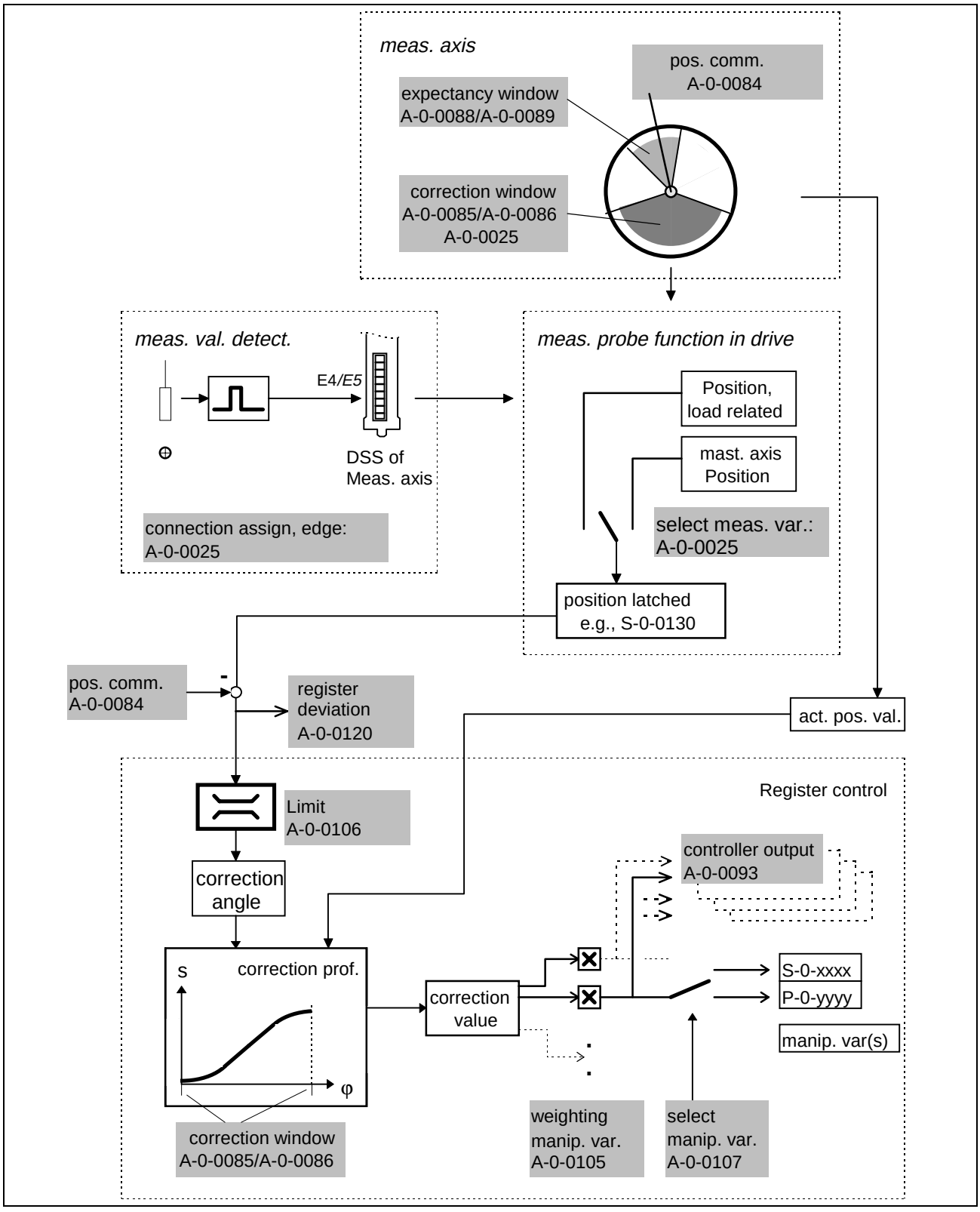


Fig. 7-51: Block diagram for direct correction with position measurement

Indirect correction with position measurement

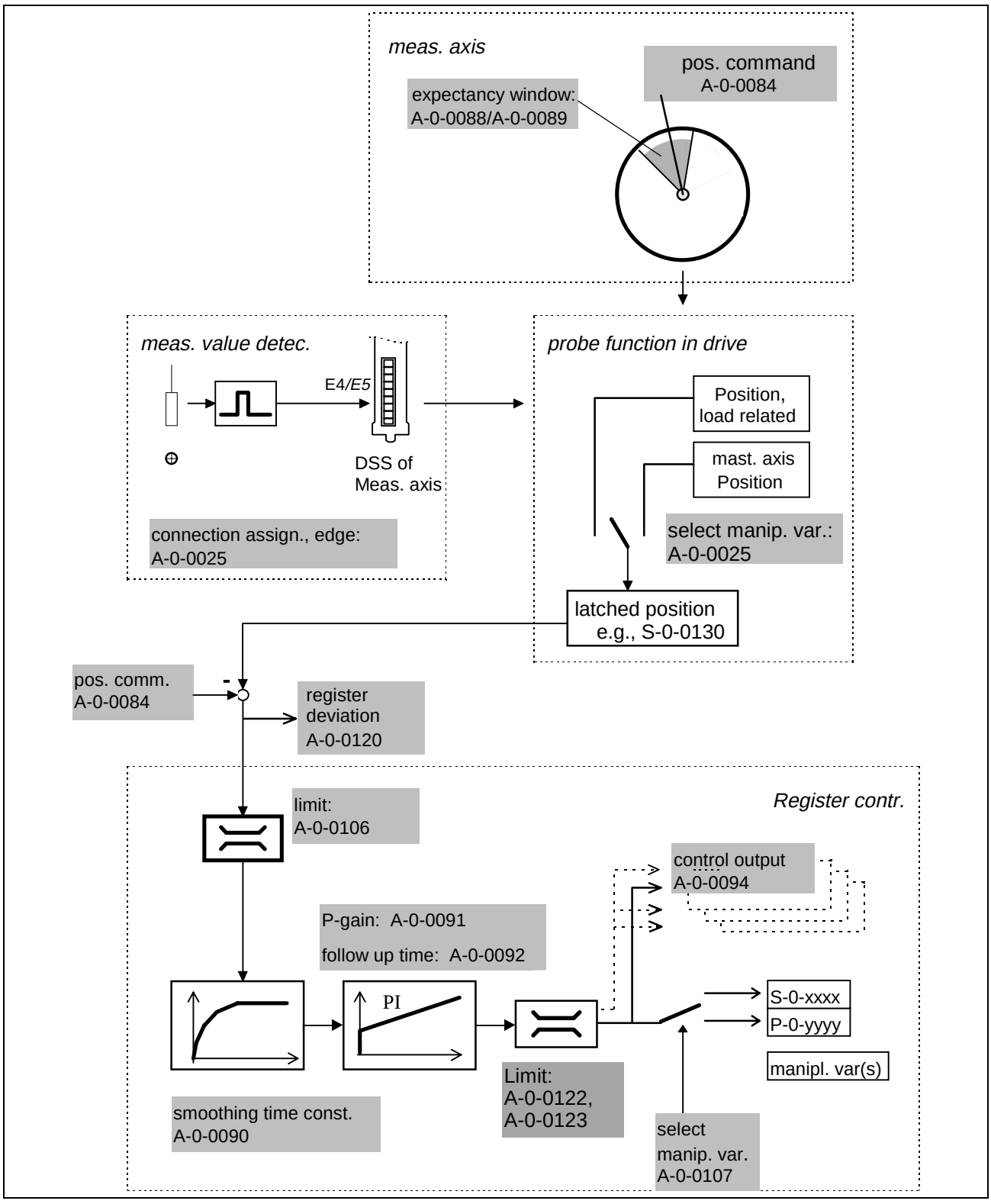


Fig. 7-52: Block diagram for indirect correction with position measurement

Direct correction with time measurement

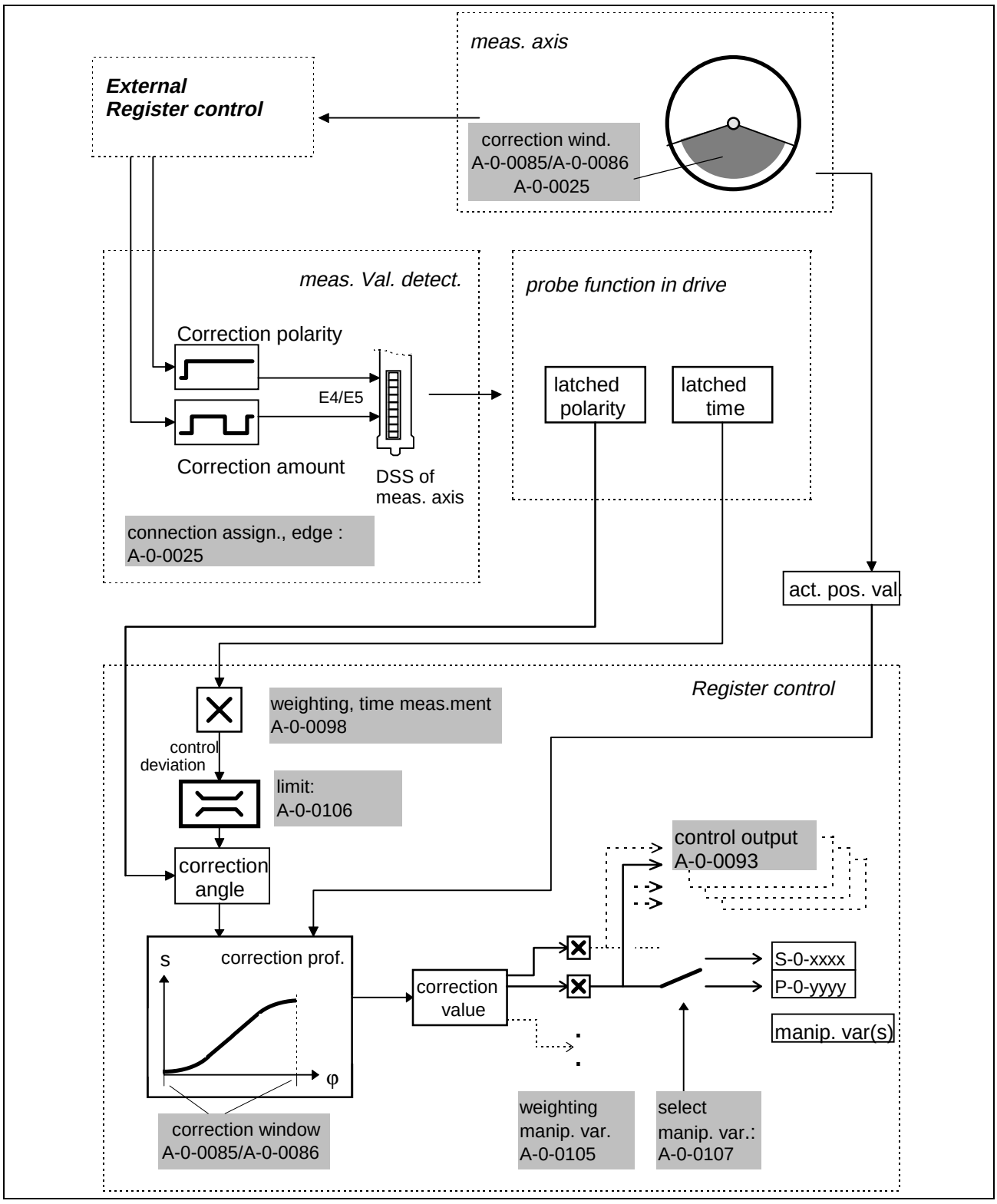


Fig. 7-53: Block diagram for direct correction with time measurement

7.7 Parameter overview

Measuring axis parameters

The following parameters must be set at the measuring axis depending upon the type of correction that is to be made:

Correction: / Measurement:		Direct position	Direct time	Indirect position	*)
A-0-0025	process control - control word 1	x	x	x	B
A-0-0084	register control - position command	x	x	x	K
A-0-0085	register control - start of correction angle	x	x		K
A-0-0086	register control - end of correction angle	x	x		K
A-0-0087	register control - drive addresses	x	x	x	B
A-0-0088	register control - negative limit monitoring window	x	x	x	K
A-0-0089	register control - positive limit monitoring window	x	x	x	K
A-0-0090	register control - smoothing time constant			x	K
A-0-0091	register control - proportional gain			x	K
A-0-0092	register control - integral action time			x	K
A-0-0098	register control - time measuring weighting		x		B
A-0-0106	register control - maximum correction	x	x		K
A-0-0122	indirect register control - positive control output limit			x	K
A-0-0123	indirect register control - negative control output limit			x	K
A-0-0125	register control - position command increments	x		x	B
A-0-0127	register control - max. register mark losses	x		x	K
A-0-0128	register control - probe delay time compensation	x		x	K

Fig. 7-54: Measuring axis parameters

*) B - write protected in operating mode
K - no write protection

Parameter for controlled axis/axes

direct register control - correction value weighting (A-0-0105)
register control - target parameter selection (A-0-0107)

Parameter for diagnoses

Controller output (controlled axes):

direct register control - correction value (A-0-0093): controlled axes
indirect register control - correction value (A-0-0094): controlled axes
register control - register deviation (A-0-0120): measuring axis

Measuring probe function (measuring axis):

probe 1 (S-0-0401)
probe 2 (S-0-0402)

Measured value with position measurement (measuring axis):

probe value 1 positive edge (S-0-0130)

probe value 1 negative edge (S-0-0131)

probe value 2 positive edge (S-0-0132)

probe value 2 negative edge (S-0-0133)

Measured value with time measurement (measuring axis):

difference probe value 1 (P-0-0202)

difference probe value 2 (P-0-0203)

7.8 Commissioning notes

Note: The following diagnostics possibilities can only be used if the register control is activated.

Impulse detection

The measuring probe inputs E4/E5 on the DSS module of the measuring axis are illustrated drive-internally on two parameters. With the help of these parameters, it is possible to cyclically display the signal status at the respective measuring probe input.

Measuring probe input on the DSS module	Parameter (measuring axis)
E4	"probe 1" (S-0-0401)
E5	"probe 2" (S-0-0402)

Fig. 7-55: Measuring probe function: controlling input impulses

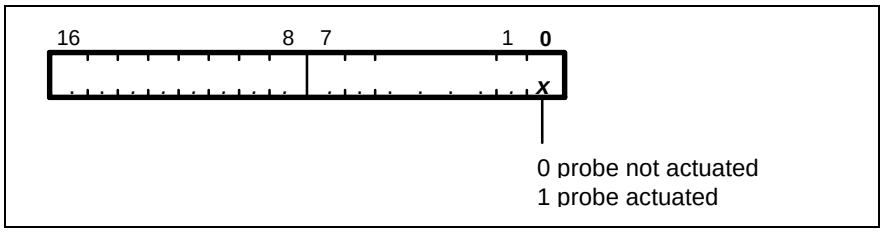


Fig. 7-56: Parameter "measuring probe 1/2"

Measured values

Measured values are stored in the drive parameters and can be read, for example, for control purposes with the use of SynTop.

Measured value with position measurement

Meas. probe input on the DSS module	Edge	Parameter (measuring axis)
E4	positive	probe value 1 positive edge (S-0-0130)
E4	negative	probe value 1 negative edge (S-0-0131)
E5	positive	probe value 2 positive edge (S-0-0132)
E5	negative	probe value 2 negative edge (S-0-0133)

Fig. 7-57: Measuring probe function: measured value with position measurement

Measured value with time measurement

With the use of an external register control, the length of the impulse of the signal "correction amount" is measured in µs instead of the actual position value.

Meas. probe input on the DSS module	Parameter (measuring axis)
E4	"difference measured value-1" (P-0-0202)
E5	"difference measured value-2" (P-0-0203)

Fig. 7-58: Measuring probe function: measured value with time measurement

Displaying process variables

Register control output

The output variable of the register control (correction value) can be cyclically displayed, for example, with the SynTop commissioning program. There are separate parameters for direct and indirect correction.

Type of correction	Parameter
direct	"direct register control - correction value" (A-0-0093)
indirect	"indirect register control - correction value" (A-0-0094)

Fig. 7-59: Actual value display: manipulated variable of the register control

Note: The output variables of the register control (parameter A-0-0093 or A-0-0094) are allocated to the controlled axes and can be read there.

If a register control affects several axes, then it is possible to read the output value allocated to each controlled axis.

Manipulated variable in drive

Depending on the setting in parameter "register control - target parameter selection" (A-0-0107) the register control effects one selected drive parameter.

The manipulated variable can, for example, be read from the controlled axis and cyclically displayed using the SynTop commissioning program.

8 Winding Control without sensors

8.1 Function principle

The winding control without sensors generates a constant tension at a windings axis. The web tension is defined by controlling a torque of the windings axis. Additional measuring elements are not needed.

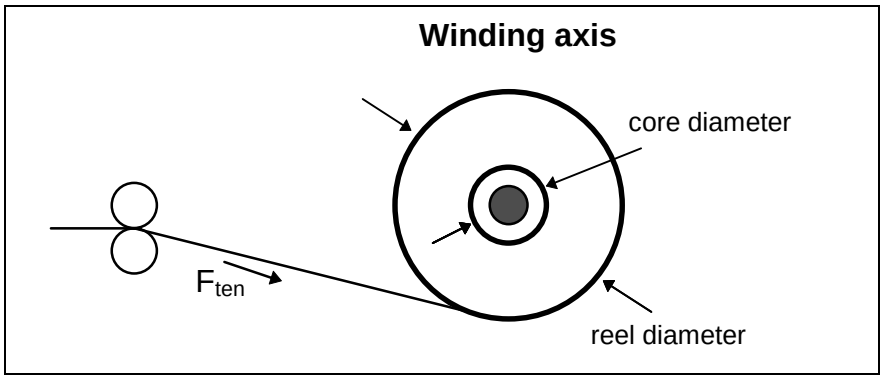


Fig. 8-1: The principle of winding

Range of functions:

- The winding on or off of web onto or off of a winder.
- The web tension during a windings process, the operational web tension, can be parametrized separately of the web tension of the windings axis at a standstill, the web tension at standstill.
- If the web is not tensed, then it will be tensed by the windings axis.
- The frictional compensation can compensate either standstill or speed-dependent frictional forces.
- The actual value is monitored.

Note: The winding control without sensors is suited for central driven winders.

8.2 Functions

Winding up and down

The web can be wound either up or down from either above or below.

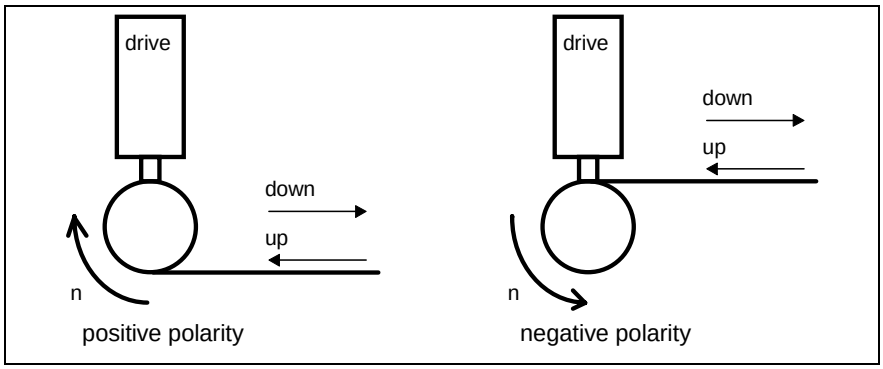


Fig. 8-2: Winding up and down

The four different applications are configured with the help of two parameters. The function of winding up or down is set in "process control - control word 2" (A-0-0146). The rotational direction of the winding axis as it relates to the master axis is set with the use of the drive parameter "Lead drive polarity" (P-0-0108).

Calculating diameters

The torque of the winding drive is the product of

web tension x radius of the reel.

It is thus necessary to constantly determine radius or the reel diameter winder.

Upon activating the winding control via the binary inputs "process controller ON", the reel diameter is not calculated until approximately one rotation of the winder has been completed. Diameter calculation is not activated until there is web tension in the web. The cyclical calculation of the reel diameter in a tensed state takes place approximately once per each rotation of the winding drive.

For diagnostics purposes, the current reel diameter can be read via a parameter.

Note: The preconditions for a correct calculation of the diameter are the correct settings for the electronic gear ratios between master axis and winding drive and for the diameter of the empty reel (compare with Settings for diameter calculations, page 8-6).

Tensing the web

With the enable signal of the winding control, the web is first brought into a state of tension at "tensing speed". The master axis should be at standstill to prevent a loop forming in the web.

The web is considered to be in a state of tension once the following conditions have been met:

- The torque command value of the drive exceeds 1.0%.
- The relative deviation between torque command and actual values is less than 25%.

There is a choice between two processes, viz.,

- tensing at a constant tensing speed and
- tensing at constant web speed

when bringing the web into a state of tension. Parameter "process control - control word 2" (A-0-0146) is used for configuration.

Tensing at constant tensing speed

The tensing speed is constant with this process. It is set with the help of parameters "tension speed" (A-0-0097) and "fine adjustment" (A-0-0060).

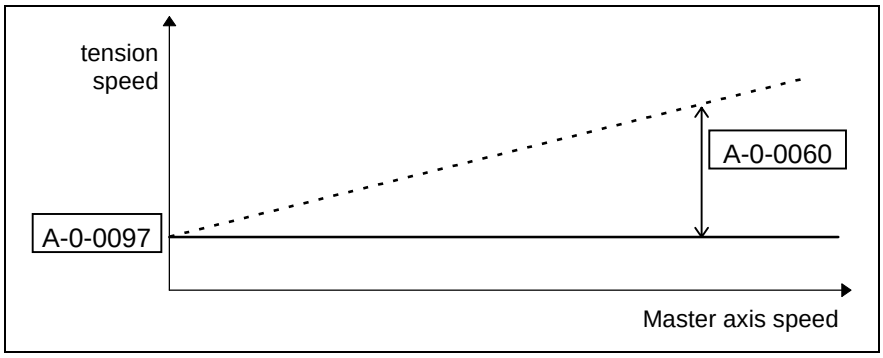


Fig. 8-3: Constant tension speed

Tensing at constant web speed

When winding with constant web speed, tensing speed, as dependent upon current reel diameter, is constantly recalculated.

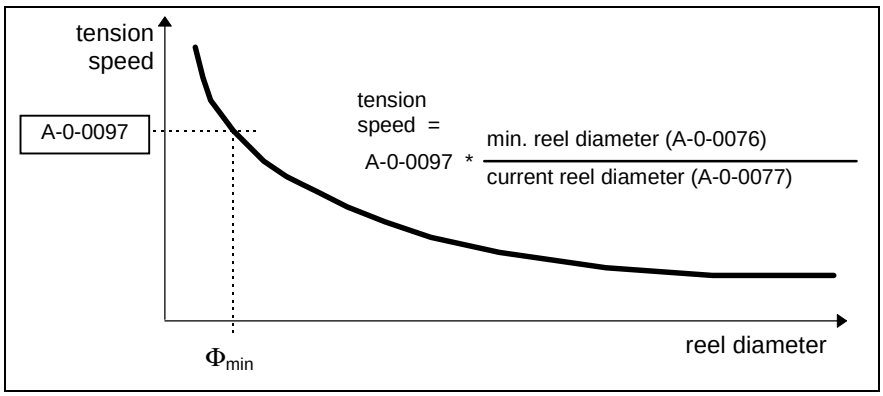


Fig. 8-4: Diameter dependent tension speed

"Tension speed" with empty reel must be entered in parameter A-0-0097.

Switching from operating to standstill web tension

The switching from operational to standstill tension is automatically performed. It is conducted via the standstill message of the drive.

Reference axis of the winding drive

The 'reference axis' of the winder is the axis that is used for the diameter calculation. Reference axis can be the master axis or any following axis.

A following axis can be used as a reference axis if

- following axis and winding axis are controlled by the same CLC

  and
- the following axis runs in velocity or phase synchronization.

The reference axis is selected with parameter "winding control - reference axis drive address" (A-0-0100):

reference axis = master axis: A-0-0100 = 0

reference axis = following axis: A-0-0100 = drive address

Changing rolls

The reel diameter is generally drastically different once the reels are changed. The internal value calculated just prior to the change is not identical to the current diameter.

A "process controller preset 1" (_E:F#.19) is needed for the diameter calculation to correctly make contact with the renewed start. Parameter "process controller - reel diameter - preset" (A-0-0078) must contain the current reel diameter as the initial value.

Note: Malfunctions can occur if preset is not conducted.

Setting the preset value

The parameter "process controller - reel diameter - preset" (A-0-0078) should be set with a diameter that is

- little smaller than the actual value for upwinding
- and a bit greater than for the unwinding.

8.3 Binary I/Os of the winding control

Binary inputs winding control without sensors

Designation	Function
_E:F#.18	process controller ON
_E:F#.19	process controller preset 1

Fig. 8-5: Binary inputs of the winding control without sensors

Activating the winding control

The winding control is activated with the binary input "process controller ON" (_E:F#.18).

Preset function

By setting the input "process controller preset 1" (_E:F#.19) an initial value is fixed for diameter calculations as is, for example, the requirement after a reel is changed. The value parametrized in "process controller - reel diameter preset" (A-0-0078) is assumed as the initial value of the current reel diameter.

Binary outputs winding control without sensors

Designation	Function
_A:F#.18	Process controller ON ack.
_A:F#.19	Process controller preset ack.
_A:F#.20	Process variable in process window
_A:F#.27	Winding control engaged

Fig. 8-6: Binary outputs of the winding control without sensors

Acknowledge process control ON

The activation of the winding control (_E:F#.18, "Process controller ON") is acknowledged with this output.

Acknowledge process control preset

Output "Process controller preset ack." (_A:F#.19) acknowledges that the starting value for the calculation of the diameter has been preset.

Process variable in process variable window

Output "Process variable in process window" (_A:F#.20) is set if the web tension lies within the programmed process variable window.

Winding control engaged

Once the winding control is activated, output "Winding control engaged" (_A:F#.27) is set as soon as the first diameter calculation has been conducted.

An engaged state can be abandoned in the following instances:

- deactivation of process control via binary input,
- transition to a state without tension or
- a command value jump.

8.4 Parametrization

Configuration of winding axis

The winding drive must be configured as a rotary modulo axis with operating mode "speed synchronization".

If a following axis has been selected to perform as the reference axis for the winding drive, then a synchronization mode must be set in parameter A-0-0003 for this axis (speed or phase synchronous).

Configuration of the winding control

The winding control is activated in "process control - control word 2" (A-0-0146). This parameter also fixes the direction of the winding action and the tensioning process.

Reference axis

The reference axis for the winding drive is selected in parameter "winding control - reference axis drive address" (A-0-0100).

If the *master axis* is the reference axis, then this parameter must be set to ’0’.

If a *following axis* is the reference axis, then the address of this following axis must be entered.

Settings for diameter calculations

The reel diameter is derived from "process controller - minimum reel diameter" (A-0-0076) and the transmission ratio between master and winding axis relating thereto.

The diameter of the empty reel is entered in parameter "process controller - minimum reel diameter" (A-0-0076).

The transmission ratio between master and winding axis is set with the help of parameter "lead drive 1 rotation" (S-0-0236) and "slave drive rotations I" (S-0-0237). The setting must be made in such a way that the web speed of the material being wound is equal to the circumference speed of the empty reel.

It applies:

$$\ddot{u} = \frac{S-0-0237}{S-0-0236} = \frac{\text{speed of the material to be wound}}{\pi \text{ x winding axis diameter empty x master axis speed}}$$

Fig. 8-7: Settings for diameter calculations

Example: Given a master axis speed of 100 rpm, the speed of the web equals 50 m/min.

The core has a diameter of 100 mm.

Transmission ratio:

$\ddot{u}$ = (50 m/min) / ($\pi \bullet$ 0.1 m $\bullet$ 100 rpm) $\approx$ 1.6 = S-0-0237 / S-0-0236

$\Rightarrow$ S-0-0236 = 5, S-0-0237 = 8

Presets and limit values

The following parameters must be checked or set:

Parameter	Setting
Virtual master - speed command 1 (C-0-0006)	initial value = 0 rpm
Process command value 1 (A-0-0026)	This parameter sets the operational web tension. A low value should be set at first (e.g., 0.5 N).
Fine adjustment (A-0-0060)	initial value = 0%
Process variable window (A-0-0061)	The value required for the monitoring of the web tension is set in this parameter (e.g., 2%).
Process variable setpoint 2 (A-0-0079)	This parameter sets the web tension at standstill. A low value should be set at first (e.g., 0.5 N).
Friction at standstill (A-0-0080)	initial value = 0%
Friction at maximum speed (A-0-0081)	initial value = 0%
bipolar velocity limit value (S-0-0091)	This parameter sets the maximum speed for the winding drive.
Standstill window (S-0-0124)	The standstill message of the drive is used for automatically switching from standstill tension to operational web tension. The zero velocity window is set to a low value (e.g, 0.5 rpm).

Fig. 8-8: Presettings and limit values

Block diagram for winding control

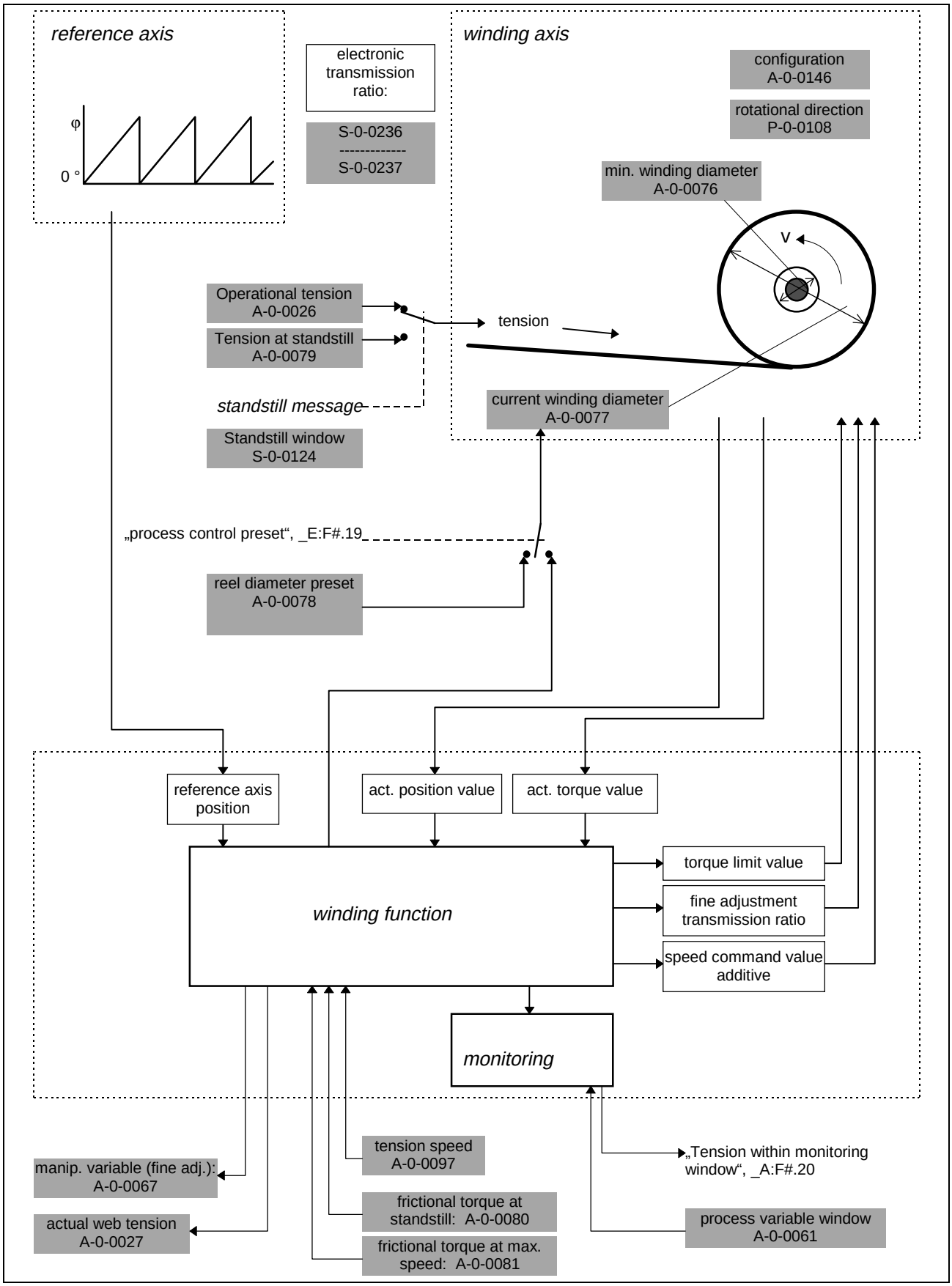


Fig. 8-9: Block diagram for winding control

8.5 Commissioning the winding control

Friction torque at standstill

"Friction at standstill" (A-0-0080) is determined with the master axis at standstill and an empty reel.

Inputs "process controller ON" (_E:F#.18) and "process controller preset 1" (_E:F#.19) are not activated (’0’) at first.

Parameter "tension speed" (A-0-0097) is set at a low speed (e.g., 10 rpm).

The winding control is released via input "process controller ON" (_E:F#.18).

The winding drive is enabled via input "synchronization mode" (_E:F#.05).

Parameter "friction at standstill" (A-0-0080) is incrementally increased until the drive begins to turn.

The process control enable is cancelled.

The enable for the winding drive ("synchronization mode" (_E:F#.05)) is cancelled.

This concludes the setting of parameter "friction at standstill" (A-0-0080).

Friction torque at maximum speed

"Friction at maximum speed" (A-0-0081) is determined with the master axis at standstill and the reel empty.

Inputs "process controller ON" (_E:F#.18) and "process controller preset" (_E:F#.19) are not active (’0’).

Parameter "tension speed" (A-0-0097) is set to the maximum speed of the winder (compare with "bipolar velocity limit value" (S-0-0091)).

The "friction at maximum speed" (A-0-0081) is set to 100 %.

The winding control is enabled via input "process controller ON" (_E:F#.18).

The winding drive is enabled via input "synchronization mode" (_E:F#.05).

The winding drive now accelerates to maximum speed.

Parameter "friction at maximum speed" (A-0-0081) is incrementally dropped until the speed of the drive begins to slow down. The speed can be controlled via drive parameter "velocity feedback value" (S-0-0040).

The enable signal of the process control is cancelled.

The enable signal of the winding drive ("synchronization mode") is cancelled.

The setting of parameter "friction at maximum speed" (A-0-0081) is thus concluded.

Rotational direction of the winding axis

The rotational direction of the winding is set with the help of "lead drive polarity" (P-0-0108):

P-0-0108 = 00000000 00000000: positive polarity

= 00000000 00000001: negative polarity

If the winding axis does rotate in the desired direction, then the parameter P-0-0108 must be reset.

Note: The parameter "lead drive polarity" (P-0-0108) can only be changed in parametrization mode.

Final settings

Parameter	Settings
Operational web tension	The required tension is set in parameter "process command value 1" (A-0-0026).
Web tension at standstill	The required standstill web tension is set in parameter "process variable setpoint 2" (A-0-0079).
Fine adjustment preset	**Winding up:** Parameter "fine adjustment" (A-0-0060) is set to a low value of up to 2.00 %. **Winding down:** Parameter "fine adjustment" (A-0-0060) is set to a low value of up to -2.00 %.
Winding control - tension speed	**Winding with constant tensing speed:** "tension speed" (A-0-0097) is set to desired value. **Winding with constant web tension:** In "tension speed" (A-0-0097) tension speed is entered with empty winder.

Fig. 8-10: Setting operating variables

Initial startup of the winding axis

The web is strung in but not tensed, i.e, it is hanging slightly.

The winding control is activated ("process controller ON"). The winding axis is now enabled ("synchronization mode").

The web must be tensed with "tension speed" (A-0-0097).

Output "process variable in process window" (_A:F#.20) must now be set. If this message is not received, then the "process variable window" (A-0-0061) must be corrected.

The master axis is enabled at a low speed, e.g., 10 rpm. After several rotations of the winding axis, the output "winding control engaged" (_A:F#.27) must have become active.

With engaged winding control, it is now possible to check the web tension for both standstill and operation.

Parameter "process controller - current reel diameter" (A-0-0077) displays the results of diameter calculations. The value which has been determined must be approximately equal to the actual reel diameter.

8.6 Parameter overview winding control without sensors

Listed below are all winding control relevant CLC system parameters. (For details see "SYNAX Parameter Description", DOK-SYNAX*-SY*-06VRS**-PA01-EN-P.)

Operating data

Parameter number	Designation
A-0-0026	Process command value 1
A-0-0027	Process actual value
A-0-0060	Fine adjustment
A-0-0061	Process variable window
A-0-0064	Process variable increments
A-0-0067	Process controller - actual value 1 (fine adjustment)
A-0-0075	Process controller - preset 1 (fine adjustment)
A-0-0076	Process controller - minimum reel diameter
A-0-0077	Process controller - current reel diameter
A-0-0078	Process controller - reel diameter - preset
A-0-0079	Process variable setpoint 2
A-0-0080	Friction at standstill
A-0-0081	Friction at maximum speed
A-0-0097	Tension speed
A-0-0100	Winding control - reference axis drive address
A-0-0146	Process control - control word 2
S-0-0080	Torque/force command
S-0-0092	Bipolar torque/force limit value
S-0-0236	Lead drive 1 rotation
S-0-0237	Slave drive rotation I

Fig. 8-11: Parameters for the winding control

9 Winding control with dancer

9.1 Function principle

The winding control with dancer is used with central driven winders.

The tension is set by a force applied at the movable part of the dancer. This force can be applied by weight, a coil or pneumatics.

The dancer control controls the dancer position. The actual value of the dancer position is evaluated with the help of an analog channel.

The winding control calculates the current reel diameter.

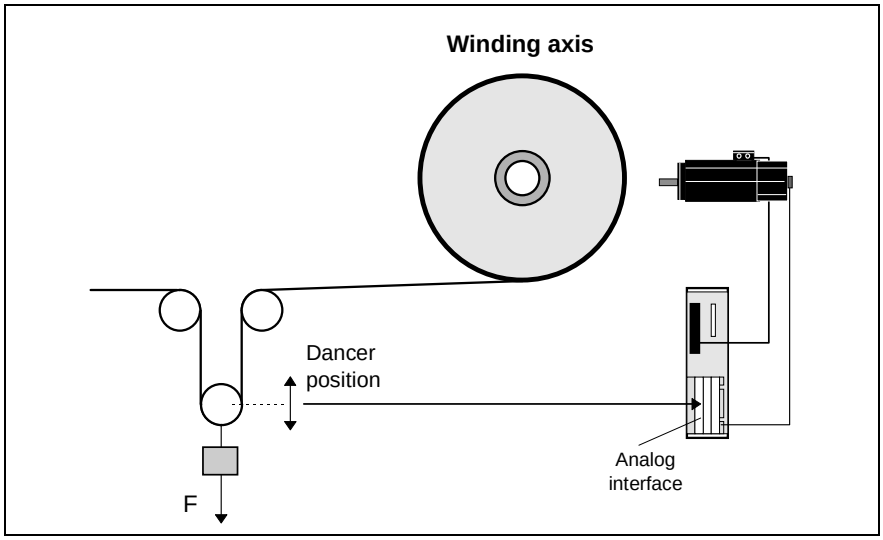


Fig. 9-1: Winding with dancer

9.2 Functions

Dancer control

The dancer control is a PI controller. The proportional gain and the integral action time are set with parameters “process controller - proportional gain 1“ (A-0-0030) and “process controller - integral action time 1“ (A-0-0029).

The P-gain follows in inverted proportion to the current reel diameter.

The dancer control effects the "additive velocity command value" (S-0-0037) of the winding axis.

The polaritiy of the manipulated variable (control polarity) is set in "process control - control word 2" (A-0-0146).

Manipulated variable limits

The controller output limitation follows linearly with the master axis speed. The linear curve is fixed with parameters

- “Process controller - bipolar limit value 2 op. point 1“ (A-0-0150),
- "Process controller - positive limit 2 operation point 2" (A-0-0138),
- "Process controller - negative limit 2 operation point 2" (A-0-0139),
- "Process controller - bipolar speed operation point 2" (A-0-0160).

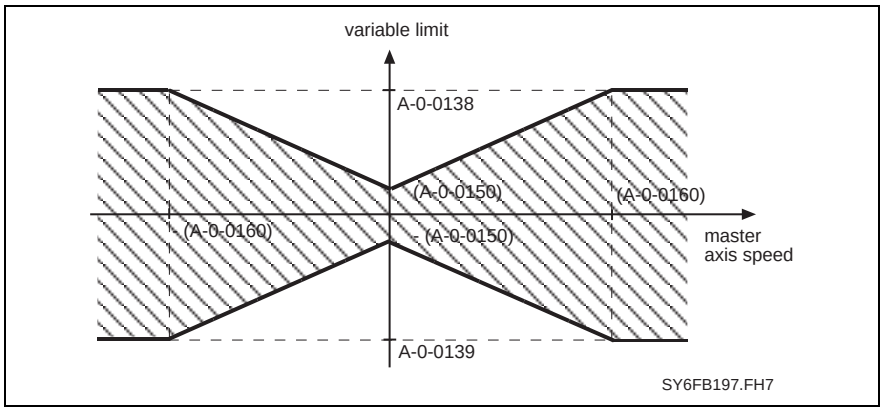


Fig. 9-2: Manipulated variable limits

The "bipolar limit value 2 op. point 1" limits the speed with which the dancer moves during machine standstill in its command position.

The parametrized curve relates to the empty reel. The effective limitation is converted in terms of

core diameter / current diameter

to the current reel diameter.

Command value setting

The command value for the dancer position can be either digital (A-0-0026) or analog.

Note: The dancer control requires a positive command value.

If the command value is set via parameter A-0-0026, then the parametrized value can be changed even with the CLC jogging function. To direct the jog inputs to the dancer position command value it is necessary to set parameter "jogging mode with speed synchronization" (A-0-0013) to a value of "2".

Actual value detection

The dancer control processes analog actual values. The method of measuring is configured in "process control - control word 2" (A-0-0146).

As the dancer control processes positive command values only, also the current value must lie within a positive range. If the measurement results in bipolar or negative values, then the measured signal must be converted into a positive signal using an offset.

Example:

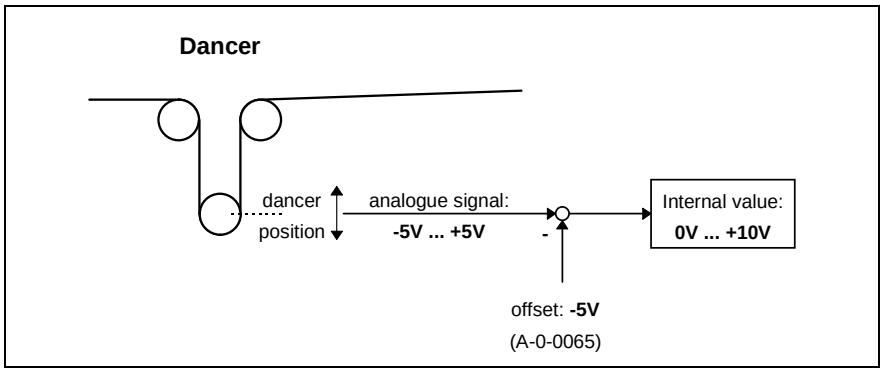


Fig. 9-3: Dancer position, current value scaling

Diameter calculation

The relationship of the measured dancer position to winding drive uses the diameter ratio

Current reel diameter / core diameter.

The diameter of the reel must, therefore, be continuously determined.

Depending on a current diameter the velocity of the winding axis is adapted via gear ratio fine adjust. Using parameter "process controller - diameter smoothing time op. point 1 (2)" (A-0-0147 and A-0-0148) it is possible to set a diameter dependent adaption of diameter smoothing.

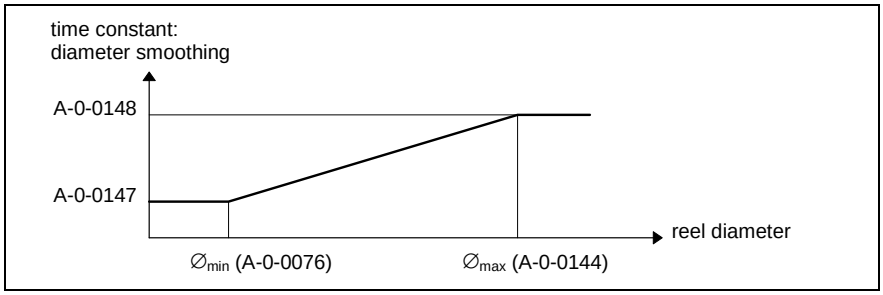


Fig. 9-4: Diameter smoothing

The diameter calculation is only active if the measured dancer position lies within the programmed limit values (A-0-0062, A-0-0063).

The cyclical calculation of the reel diameter takes place once per revolution of the winding drive.

Reel diameter presetting

After a reel is exchanged, the winding diameter is also abruptly changed. The previuosly computed internal value no longer corresponds to the current diameter.

For the diameter calculation with a restart to be correct a "process controller preset 1" (_E:F#.19) is needed. Parameter "process controller - reel diameter - preset" (A-0-0078) must contain the current reel diameter as starting value.

Note: The "process controller preset 1" must be concluded before the winding control is activated.

Format setting

The ratio between winding axis and master axis is set in the master axis gear:

- "master drive gear input revolutions" (P-0-0156)

  = circumference of empty reel,

- "master drive gear output revolutions" (P-0-0157)

  = product length within 1 master axis rotation (format length).

During format change the winding controller must be deactivated. New settings become valid after the next switch on.

The electronic gear ratio for winding axes (Parameter S-0-0236, S-0-0237) must be set to 1:1.

Monitoring and diagnoses of the winding control with dancer

Dancer

Dancer position actual value (A-0-0027) and controller output (A-0-0137) can be displayed for diagnostics.

Note: In a set state (dancer position in process variable window, diameter calculation active), the influence of the dancer control drops (controller output < 1.0000 rpm). If the additive velocity command value is not reduced then check master axis polarity and the master axis gear.

The dancer position is continuously checked for maintaining programmed windows (A-0-0061) and exceeding programmed limit values (A-0-0062, A-0-0063). The tripping of a monitor is signalled to the PLC via a binary output (see "Binary outputs of the winding control with dancer " on page 9-8).

Winding diameter

The "process controller - current reel diameter" (A-0-0077) and output “process controller - actual value 1 (fine adjustment)“ (A-0-0067) can be read out for diagnostics.

The reel diameter is continuously checked for exceeding programmed limit values (A-0-0076, A-0-0144). The tripping of a monitor is signalled to the PLC via a binary output. Also, the current reel diameter is constantly compared with the "process controller - reference diameter" (A-0-0149). If the comparative value is exceeded, then a binary output is set (see "Binary outputs " on page 9-8).

Rotational direction of the winding axis

The web can be wound coming from either above or below.

The rotational direction of the winding axis in terms of the master axis is preset in drive parameter "lead drive polarity" (P-0-0108).

The preset direction can be inverted by setting binary input "synchronization mode - reverse direction" (_E:F#.41).

Reference axis of the winder

The ’reference axis’ of the winder is the axis that is used for the diameter calculation. Reference axis can be the master axis or any following axis.

A following axis can be used as a reference axis if

- following axis and winding axis are controlled by the same CLC

  and

- the following axis runs in velocity or phase synchronization.

The reference axis is selected with parameter "winding control - reference axis drive address" (A-0-0100):

reference axis = master axis: A-0-0100 = 0

reference axis = following axis: A-0-0100 = drive address

9.3 Binary input/output of winding controller with dancer

Overview binary I/Os of the winding control with dancer

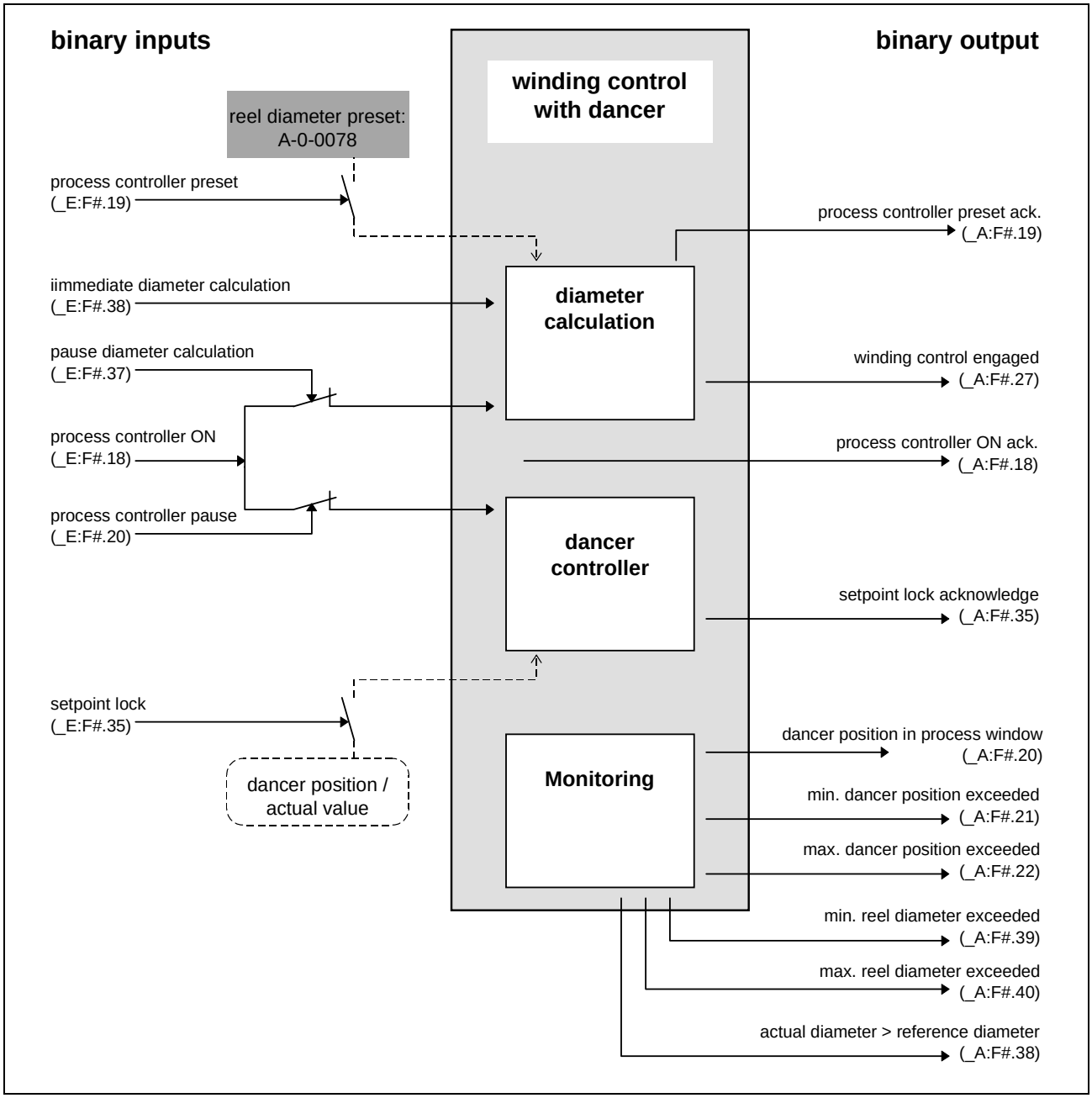

binary inputs
binary output
winding control with dancer
reel diameter preset: A-0-0078
process controller preset (_E:F#.19)
process controller preset ack. (_A:F#.19)
iimmediate diameter calculation (_E:F#.38)
diameter calculation
pause diameter calculation (_E:F#.37)
winding control engaged (_A:F#.27)
process controller ON (_E:F#.18)
process controller ON ack. (_A:F#.18)
process controller pause (_E:F#.20)
dancer controller
setpoint lock acknowledge (_A:F#.35)
setpoint lock (_E:F#.35)
dancer position / actual value
Monitoring
dancer position in process window (_A:F#.20)
min. dancer position exceeded (_A:F#.21)
max. dancer position exceeded (_A:F#.22)
min. reel diameter exceeded (_A:F#.39)
max. reel diameter exceeded (_A:F#.40)
actual diameter > reference diameter (_A:F#.38)

Fig. 9-5: Binary I/Os - winding control with dancer

Binary inputs of the winding control with dancer

Designation	Function
_E:F#.18	process controller ON
_E:F#.19	process controller preset 1
_E:F#.20	process controller pause
_E:F#.35	process controller - setpoint lock
_E:F#.37	process controller - pause diameter calculation
_E:F#.38	process controller - immediate diameter calculation

Fig. 9-6: Binary inputs of the winding controller with dancer

Activating winding controller (_E:F#.18)

The winding controller is activated with binary input "process controller ON" (_E:F#.18). When activating the winding controller all internal variables and controller ouputs are reset. When deactivating, all controller output are reset. The state of the winding controller is signalled via output "process controller ON ack." (_A:F#.18).

Preset function (_E:F#.19)

By setting input "process controller preset 1" (_E:F#.19) a start value is set for the calculation of the diameter. The preset value is acknowledged at output _A:F#.19.

A diameter preset may only be conducted with deactivated winding control.

Process controller pause (_E:F#.20)

The manipulated variable of the dancer control is "frozen" while input "process controller pause" (_E:F#.20) is set.

Process controller setpoint lock (_E:F#.35)

If input "process controller - setpoint lock" (_E:F#.35) is set then the current dancer position is accepted as the new command value for the dancer control.

Process controller - pause diameter calculation (_E:F#.37)

The current diameter is "frozen" while input "process controller - pause diameter calculation" (_E:F#.37) is set.

Process controller - immediate diameter calculation (_E:F#.38)

The cyclical calculation of the diameter takes place about once every rotation of the winding drive. Upon activating the "immediate diameter calculation" it is possible, e.g., to increase the processing cycle for diameter calculation after an imprecise preset value.

Binary outputs of the winding control with dancer

Designation	Function
_A:F#.18	process controller ON ack.
_A:F#.19	process controller preset ack.
_A:F#.20	process variable in process window
_A:F#.21	minimum process variable exceeded
_A:F#.22	maximum process variable exceeded
_A:F#.27	winding control engaged
_A:F#.35	process controller - setpoint lock acknowledge
_A:F#.38	process controller - act. diameter > reference diameter
_A:F#.39	process controller - min. reel diameter exceeded
_A:F#.40	process controller - max. reel diameter exceeded

Fig. 9-7: Binary ouputs of the winding controller with dancer

Process controller ON ack. (_A:F#.18)

This output acknowledges activation of the winding controller ("process controller ON", _E:F#.18).

Process controller preset ack. (_A:F#.19)

The output "process controller preset ack." (_A:F#.19) acknowledges a start value for diameter calculation.

Monitoring dancer position

For actual value monitoring, there are three binary outputs available:

- **"process variable in process window" (_A:F#.20)** is set if the actual dancer position value lies within a programmable range (A-0-0061, "process variable window").
- **"minimum process variable exceeded" (_A:F#.21)** is set if the actual dancer position value exceeds the programmed minimum value "minimum process variable - monitoring window" (A-0-0063).
- **"maximum process variable exceeded" (_A:F#.22)** is set if the actual dancer position value exceeds the programmed maximum value "maximum process variable - monitoring window" (A-0-0062).

Winding control engaged (_A:F#.27)

After activating the winding controller, output "winding control engaged" (_A:F#.27) is set as soon as the first diameter calculation has been concluded.

The output is reset with:

- deactivation of the process controller via binary inputs,
- dancer position outside of the process variable window.

Process controller - setpoint lock acknowledge (_A:F#.35)

Output "process controller - setpoint lock acknowledge" (_A:F#.35) acknowledges the current actual value of dancer position as a new command value for the dancer controller.

Process controller - act. diameter > reference diameter (_A:F#.38)

This output is set if the current diameter exceeds "process controller - reference diameter“ (A-0-0149).

Process controller - min. reel diameter exceeded (_A:F#.39)

This output is set if the current diameter exceeds "process controller - minimum reel diameter“ (A-0-0076).

Process controller - max. reel diameter exceeded (_A:F#.40)

This output is set if the current diameter exceeds "process controller - maximum reel diameter“ (A-0-0144).

9.4 Block Diagram winding control with dancer

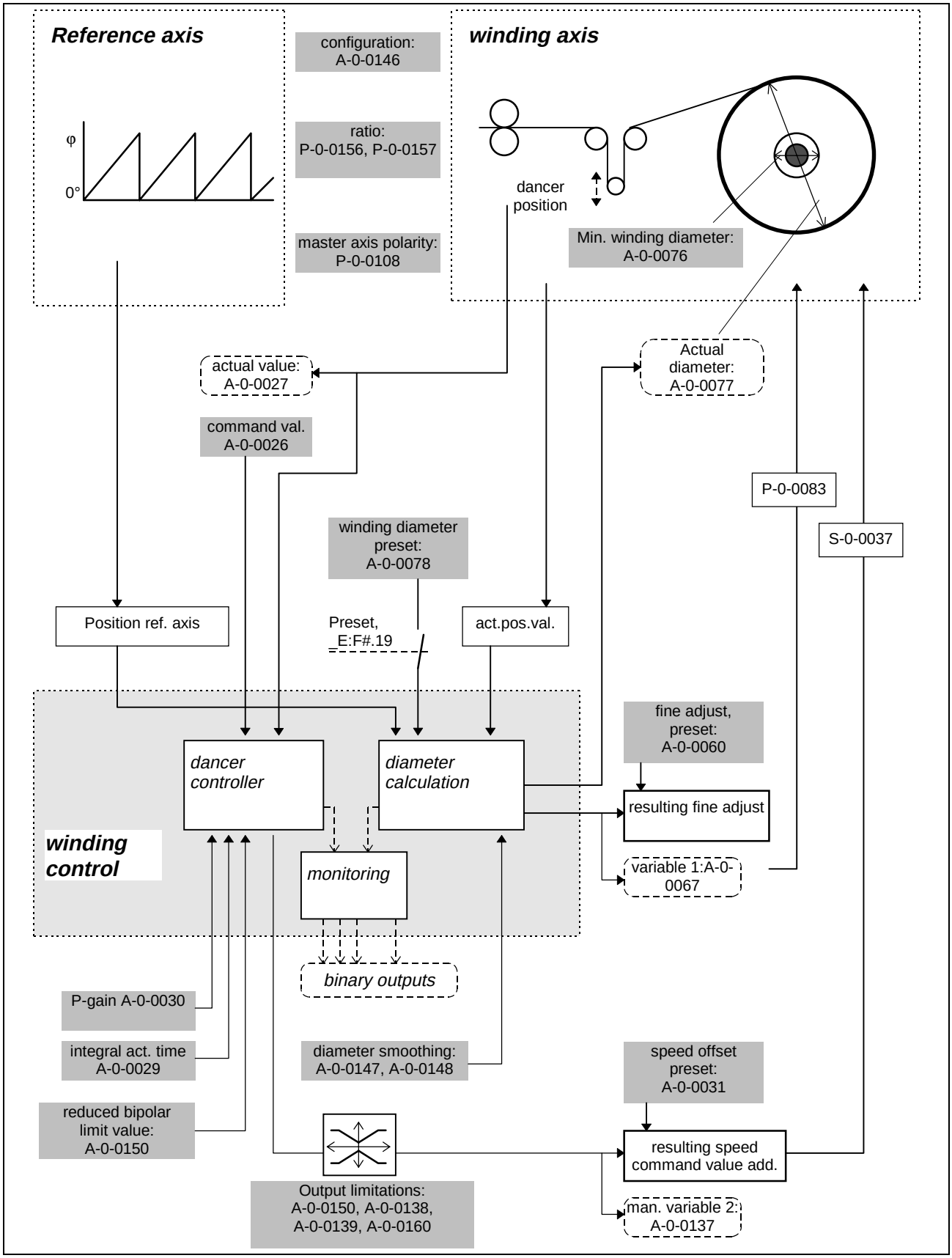


Fig. 9-8: Block diagram: Winding control with dancer

9.5 Parameter overview of winding control with dancer

The table below lists all CLC system parameters relevant for winding control with dancer.

(Detailled description, see "SYNAX Parameter Description", DOK-SYNAX*-SY*-06VRS**-PA01-EN-P.)

Parameter-Number	Designation
A-0-0026	Process command value 1
A-0-0027	Process actual value
A-0-0029	Process controller - integral action time 1
A-0-0030	Process controller - proportional gain 1
A-0-0060	Fine adjustment
A-0-0061	Process variable window
A-0-0064	Process variable increments
A-0-0067	Process controller - actual value 1 (fine adjustment)
A-0-0068	Process controller - positive limit 1
A-0-0069	Process controller - negative limit 1
A-0-0075	Process controller - preset 1 (fine adjustment)
A-0-0076	Process controller - minimum reel diameter
A-0-0077	Process controller - current reel diameter
A-0-0078	Process controller - reel diameter - preset
A-0-0100	Winding control - reference axis drive address
A-0-0137	Process controller - actual value 2 (additive velocity)
A-0-0138	Process controller - positive limit 2 operation point 2
A-0-0139	Process controller - negative limit 2 operation point 2
A-0-0144	Process controller - maximum reel diameter
A-0-0146	Process control - control word 2
A-0-0147	Process controller - diameter smoothing time op. point 1
A-0-0148	Process controller - diameter smoothing time op. point 2
A-0-0149	Process controller - reference diameter
A-0-0150	Process controller - bipolar limit value 2 op. point 1
A-0-0160	Process controller - bipolar speed operation point 2
P-0-0156	Master drive gear input revolutions
P-0-0157	Master drive gear output revolutions

Fig. 9-9: Parameter for the winding control with dancer

10 Analogue channels

10.1 Functional principles

The functionality of the analogue channels offers the possibility of inputting input variables via an analogue input interface and affect selectable target parameters.

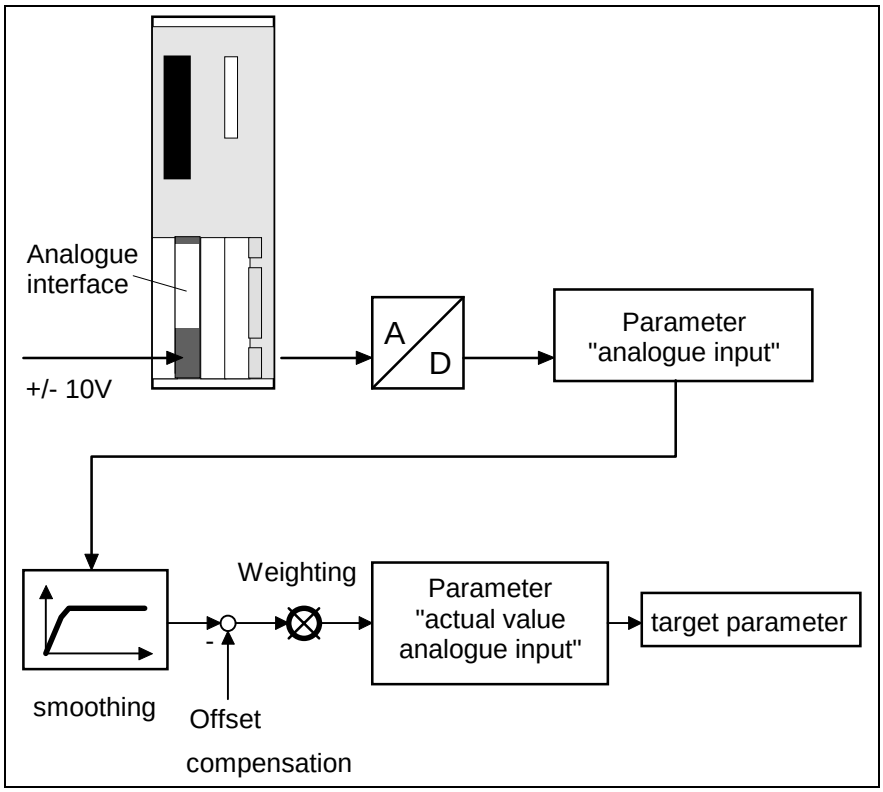


Fig. 10-1: Functional principle

Analogue interface

Depending on the installed drive firmware different plug-in modules with analogue interface are used (DOK-SYNAX*-SY*-06VRS**-PR01-EN-P, SYNAX Project planning).

Every analogue interface has two differential inputs. These are laid out for an input voltage of ±10V. The input signals are converted to a resolution of 16 bit when using a DAE02.1M plug-in card and they are converted to a resolution of 12 bit when using a DRF01.1M card.

The plug-in card with an analogue interface can be inserted into any drive controller in the SYNAX ring.

Configuration of the analogue channels

The analogue inputs are individually activated in parameter "analogue channels - analogue input control word" (A-0-0008). The polarity of the input signals is also indicated here. "Analogue channels - analogue input control word" (A-0-0008) must be parametrized for that drive in which the analogue interface is located.

Signal processing

The converted signal is depicted drive-internally in parameter "analogue input 1" or "analogue input 2". The CLC cyclially reads this value and calculates the current actual value taking into account parameters

- "analogue channels - smoothing time constant" (A-0-0066),
- "analogue channels - analogue input offset" (A-0-0065) and
- "analogue channels - analogue input weighting" (A-0-0028).

The actual value is written into parameter "analogue channels - actual value analogue input 1" (A-0-0082) or "analogue channels - actual value analogue input 2" (A-0-0083) and can be read for diagnostic purposes.

Weighting analogue variables

The weighting process initiates a scaling to the numeric range of the target parameter.

Note: The decimal places of the target parameter must be taken into account in parameter "analogue channels - analogue input weighting" (A-0-0028).

Example: An analogue signal is to affect the fine adjustment in a drive. 10V equal an adjustment of 2%.

Parameter "fine adjustment" (A-0-0060) has 2 decimal places.

⇒ "analogue input weighting" = 200

Selecting the target variables

Allocating analogue input signals to target parameters on the CLC is performed with the help of parameter "analogue channels - select source parameters" (C-0-0039) and "analogue channels - select target parameters" (C-0-0040).

The source parameters are entered in the form of a list with drive address and the channel number "analogue channels - actual value analogue input" (A-0-0082 or A-0-0083). The target parameters are entered with the information about target equipment (drive or CLC) and the respective parameter numbers is entered into a list.

Example: An analogue interface has been inserted into the drive with address 5. Channel 1 is used to specifiy master axis speed. Channel 2 is used to adjust the fine adjustment for drive 5.

Entry in C-0-0039 "select source parameters"	**Entry in C-0-0040 "select target parameters"**
A05: A-0-0082	CLC: C-0-0006
A05: A-0-0083	A05: A-0-0060

Fig. 10-2: Example of the allocation of analogue input signals

It is possible to have one analogue signal simultaneously affect several parameters, e.g., simultaneously setting the idle speed of several drives.

10.2 Configuration example

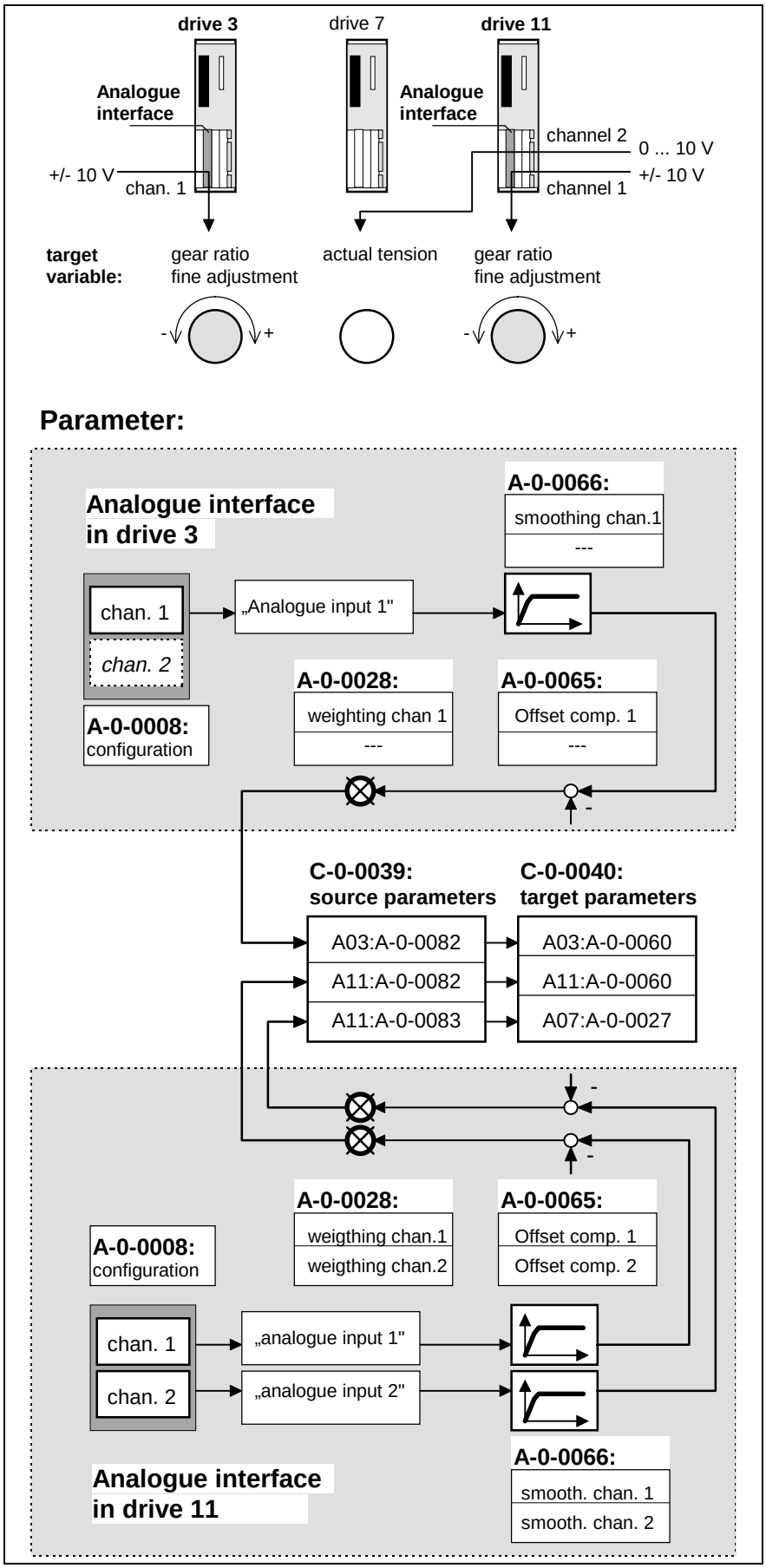


Fig. 10-3: Configurations with three analogue input signals

10.3 Parameters

The following is a list of all relevant parameters for processing analogue input variables. For details see "SYNAX Parameter Description".

Parameter number	Designation
C-0-0039	Analogue channels - select source parameter
C-0-0040	Analogue channels - select target parameter
A-0-0008	Analogue channels - analogue input control word
A-0-0028	Analogue channels - analogue input weighting
A-0-0065	Analogue channels - analogue input offset
A-0-0066	Analogue channels - smoothing time constant
A-0-0082	Analogue channels - actual value analogue input 1
A-0-0083	Analogue channels - actual value analogue input 2

Fig. 10-4: Parameter for analogue inputs

11 Jogging function

11.1 Operating principle of the jogging inputs

With the use of the jogging function it is possible to change operation mode related process variables via binary inputs (see "Binary I/Os of the jogging function", page 11-7).

Via jog inputs affected parameters

Depending on operating mode and function the jog inputs affect *one preselected* parameter.

Following axis

Operating mode	Extended function	Affected parameter	Precondition
speed synchronisation	---	fine adjustment (A-0-0060)	A-0-0013 = 0
		velocity synchronization - speed offset (A-0-0031)	A-0-0013 = 1
		master drive gear output revolutions (A-0-0126)	A-0-0013 = 4
- " -	tension control	process command value 1 (A-0-0026)	A-0-0013 = 2
- " -	register control	register control - position command (A-0-0084)	A-0-0025: Bit 21 = 1 *
phase synchronisation	---	position command offset (A-0-0004)	A-0-0153 = 0
		master drive gear output revolutions (A-0-0126)	A-0-0153 = 1
		process command value 1 (A-0-0026)	A-0-0153 = 2
- " -	register control	register control - position command (A-0-0084)	A-0-0025: Bit 21 = 1 *
electronic CAM	---	position command offset (A-0-0004)	A-0-0153 = 0
		master drive gear output revolutions (A-0-0126)	A-0-0153 = 1
		process command value 1 (A-0-0026)	A-0-0153 = 2
- " -	register control	register control - position command (A-0-0084)	A-0-0025: Bit 21 = 1 *
pattern control	---	position command offset (A-0-0004)	A-0-0153 = 0
		master drive gear output revolutions (A-0-0126)	A-0-0153 = 1
		process command value 1 (A-0-0026)	A-0-0153 = 2
idle mode	---	idle speed 0, 1, 2, or 3 (A-0-0011, A-0-0115 - A-0-0117)	activated idle speed: binary inputs _E:F#.33, _E:F#.34
setup mode	---	setup position 0, 1, 2 or 3 (A-0-0056 - A-0-0059)	activated setup position: binary inputs _E:F#.15, _E:F#.16

Fig. 11-1: Parameters affected by jog inputs (following axis)

* also see chapter 7.6 "Parametrization" - "Settings at the measuring axes"

Affected parameters of the virtual master

Affected parameter	Precondition
"virtual master - speed command 1" (C-0-0006)	virtual master with 1 speed command: "ELS master - control word" (C-0-0004) Bit 15 = Ø
"virtual master - speed commands" (C-0-0054)	virtual master with 8 speed commands: "ELS master - control word" (C-0-0004) Bit 15 = 1

Fig. 11-2: Parameters affected by jog inputs (virtual master)

If eight speed commands (C-0-0054) are used, then that speed selected via binary inputs will be changed.

Activate jogging (following axis)

To jog the following axis it is necessary to activate jogging. For this, the input "continuous manual operation" (_E:F#.09) has to be set. Jogging inputs may now be used to jog.

Jogging inputs related to the virtual master do not require an activation.

Jogging rate

The jogging rate expresses the slope of the jogged parameter. This slope is dependent upon the increment width and the jogging rate. When jogging to a position, it is calculated as follows:

$$\text{jogging rate} \left[\frac{\text{degree}}{\text{s}}\right] = \text{increment width [degree]} \times \text{jogging speed} \left[\frac{1}{\text{s}}\right]$$

If the speed of the virtual master axis is jogged, for example, then the jogging rate is calculated as:

$$\text{jogging rate} \left[\frac{\text{rpm}}{\text{s}}\right] = \text{increment width [rpm]} \times \text{jogging speed} \left[\frac{1}{\text{s}}\right]$$

One of the two jogging rates for either the following axes or the virtual master is selected via internal inputs:

Jogging rates of the following axes

Internal input:	Effective jogging speed:
"manual operation speed set" (_E:F#.11) = 0	"jogging speed" (C-0-0043)
"manual operation speed set" (_E:F#.11) = 1	"reduced jogging speed" (C-0-0044)

Fig. 11-3: Speed selection for the following axes

Jogging rates of the virtual master

Internal input:	Effective jogging speed:
"VM jogging speed reduced" (_E:L01.14) = 0	"jogging speed" (C-0-0043)
"VM jogging speed reduced" (_E:L01.14) = 1	"reduced jogging speed" (C-0-0044)

Fig. 11-4: Speed selection for the virtual master

Quick jogging

A quick jogging impulse alters a parameter by a precisely defined value, the increment width.

A jogging impulse is called "quick" if it is shorter than the time stored in parameter "jogging time constant" (C-0-0029).This time is given in ms.

Example Jogging a following axis position, jogging signal shorter than the "jogging time constant" (C-0-0029) with "incremental jogging position of following axis" (A-0-0007) and "jogging speed" (C-0-0043).

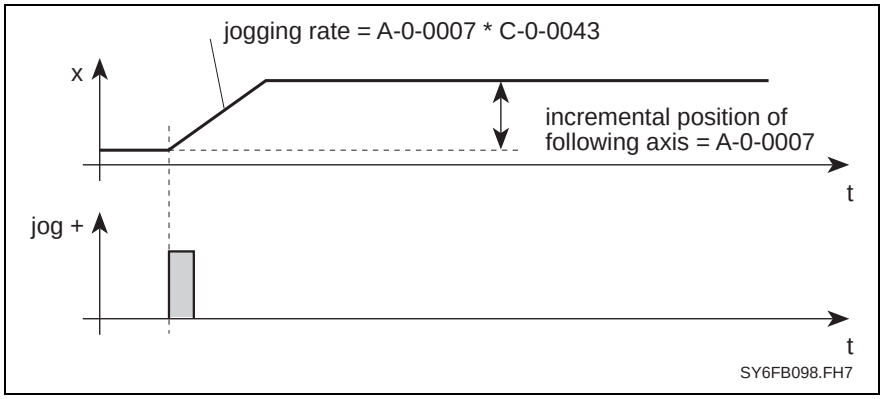


Fig. 11-5: Jogging the position of a following axis, jogging signal shorter than the "jogging time constant" (C-0-0029)

Upon completion of the motion, the drive has moved **precisely one** increment width.

Long jogging

If the jogging signal is longer than the "jogging time constant" (C-0-0029), then the selected parameter keeps changing with the defined jogging rate while the jogging signal is applied.

There is no guarantee after this that the drive is running at integer multiples of the increment width.

Example

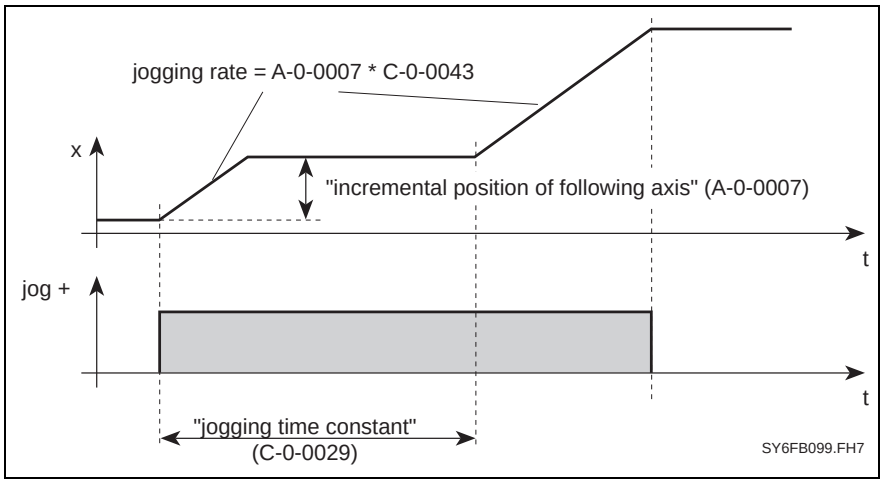


Fig. 11-6: Jogging the position of a following axis, jogging signal longer than "jogging time constant" (C-0-0029)

Note: The "jogging time constant" (C-0-0029) may be set to ’0’. In this case continuous change of a parameter starts immediately after setting a jog input.

Jog limits

Parameters may be changed within their predefined limits only (see "Jogging function parameters" page 11-8). If a limit is reached, either of the binary outputs "negative jogging limit exceeded" or "positive jogging limit exceeded" is set.

Some basic rules

- If both jogging signals are simultaneously 1 (jogging +/-), then both are evaluated as 0.
- A jogging signal which begins and ends before a running movement is completed, will be ignored.
- A jogging signal with the same polarity as the previous one, which starts before a running motion is completed, and which ends after the running motions ends, will trigger a new motion at the end of the running motion.
- A jogging signal with a different polarity immediately triggers a conversion of movement, even if the running motion is not complete.
- A change in speed takes immediate effect. Moving one increment width is an exception, however. If the speed is changed during this motion, then the change in speed will not become effective until the motion is completed.

11.2 Examples

Jogging fine adjustment gearbox transmission (A-0-0060)

"fine adjustment increments" (A-0-0014) = 2 %
"jogging speed" (C-0-0043) = 10 1/sec
"jogging time constant" (C-0-0029) = 300 ms
Calculated jogging rate = 10 1/sec · 2 %= 20 % / sec.

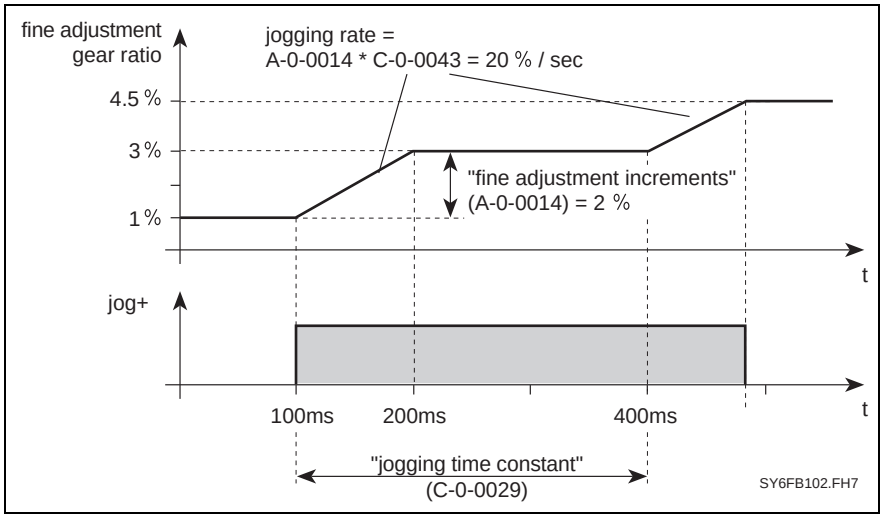


Fig. 11-7: Jogging fine adjustment - gearbox transmission

Jogging the "position command offset" (A-0-0004)

"incremental jogging position of following axis" (A-0-0007) = 0.02°
"jogging speed" (C-0-0043) = 1000 1/sec
"jogging time constant" (C-0-0029) = 3 ms
Calculated jogging rate = 1000 1/sec · 0.02° = 20 °/sec

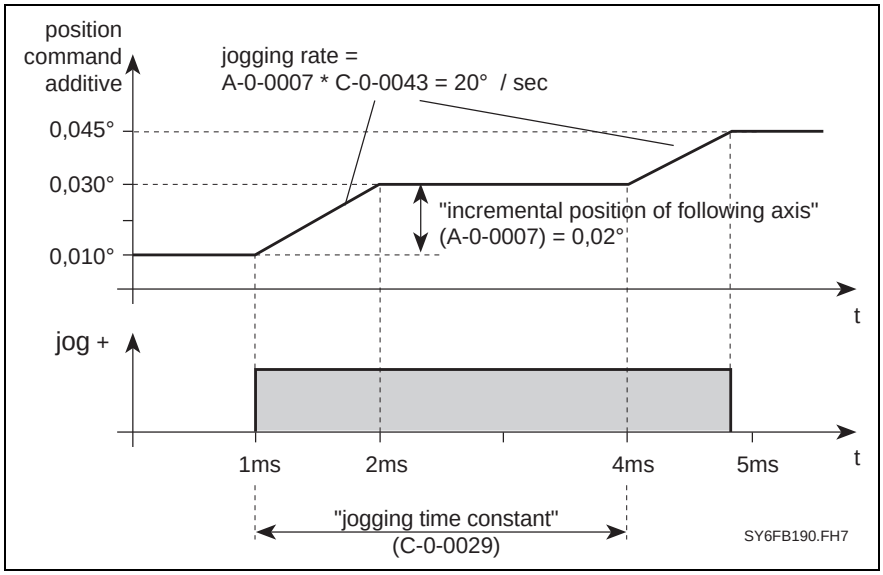


Fig. 11-8: Jogging the "position command offset" (A-0-0004)

Jogging the master drive gear output revolutions (A-0-0126)

- "master drive gear output revolution increments" (A-0-0136) = 1 rev.
- "jogging speed" (C-0-0043) = 20 1/sec
- "jogging time constant" (C-0-0029) = 300 ms

Calculated jogging rate = 20 1/sec · 1 rev. = 20 rev. /sec.

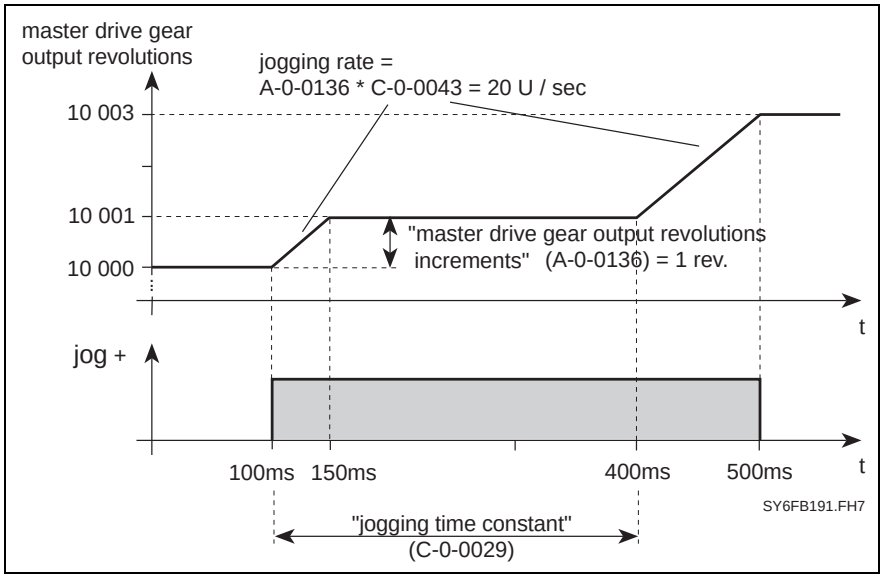


Fig. 11-9: Jogging the master drive gear output revolutions

Jogging the master axis speed (C-0-0006)

- "virtual master - speed increment" (C-0-0028) = 20 rpm
- "jogging speed" (C-0-0043) = 10 1/sec
- "jogging time constant" (C-0-0029) = 300 ms

Calculated jogging rate = 10 1/sec · 20U/min = 200 rmp /sec.

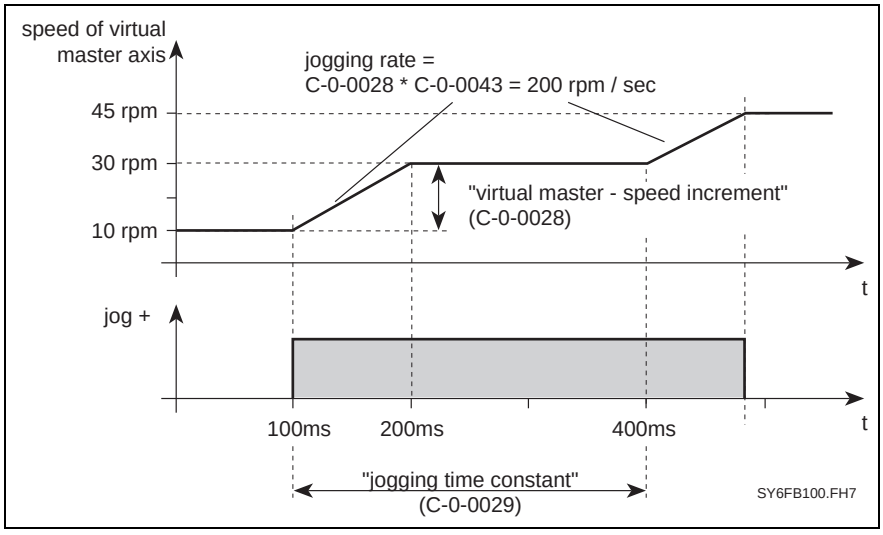


Fig. 11-10: Jogging master axis speed

11.3 Binary I/Os of the jogging function

Designation	Function
_E:L01.12	Virtual master jog -
_E:L01.13	Virtual master jog +
_E:L01.14	VM jogging speed reduced
_A:L01.21	VM negative jogging limit exceeded
_A:L01.22	VM positive jogging limit exceeded
_E:F#.09	Continuous manual operation
_E:F#.10	Manual operation grid
_E:F#.11	Manual operation speed set
_E:F#.12	Jog -
_E:F#.13	Jog +
_A:F#.07	Continuous manual operation ack.
_A:F#.08	Manual grid operation ack.
_A:F#.28	Negative jogging limit exceeded
_A:F#.29	Positive jogging limit exceeded

Fig. 11-11: Binary I/Os of the jogging function

11.4 Jogging function parameters

All relevant CLC systems paramters for jogging function are listed below. For details see "SYNAX Parameter Description".

Parameter number	Designation
C-0-0029	Jogging time constant
C-0-0043	Jogging speed
C-0-0044	Reduced jogging speed
A-0-0013	Jogging mode with speed synchronization
A-0-0153	Jogging mode with phase synchronization

Fig. 11-12: Parameters of the jogging function: General settings

The following table lists the parameters that can be affected depending upon the axis or mode to be jogged:

Designation	Jogged variable	Incre-ment width	Minimum value	Maxi-mum value
Master axis speed (1 command)	C-0-0006	C-0-0028	C-0-0031	C-0-0030
Master axis speed (8 commands)	C-0-0054	C-0-0028	C-0-0056	C-0-0055
Position command offset (phase synchronization, electronic cam)	A-0-0004	A-0-0007	A-0-0018	A-0-0017
Pattern control, continuous jog mode	A-0-0004	A-0-0007	A-0-0018	A-0-0017
Pattern control, grid mode	A-0-0004	A-0-0032	A-0-0018	A-0-0017
Idle speed 0	A-0-0011	A-0-0016	A-0-0024	A-0-0023
Tension command	A-0-0026	A-0-0064	A-0-0026	A-0-0026
Speed offset	A-0-0031	A-0-0015	A-0-0022	A-0-0021
Setup position 0	A-0-0056	A-0-0007	A-0-0035	A-0-0034
Setup position 1	A-0-0057	A-0-0007	A-0-0035	A-0-0034
Setup position 2	A-0-0058	A-0-0007	A-0-0035	A-0-0034
Setup position 3	A-0-0059	A-0-0007	A-0-0035	A-0-0034
Fine adjustment	A-0-0060	A-0-0014	A-0-0020	A-0-0019
Register control-position command	A-0-0084	A-0-0125	0°	Modulo value
Idle speed 1	A-0-0115	A-0-0016	A-0-0110	A-0-0023
Idle speed 2	A-0-0116	A-0-0016	A-0-0112	A-0-0023
Idle speed 3	A-0-0117	A-0-0016	A-0-0114	A-0-0023
Master drive gear ouput revolutions	A-0-0126	A-0-0136	A-0-0152	A-0-0151

Fig. 11-13: Jogging function parameters: process variables and limits

12 System structure with 1 CLC controller

12.1 Introduction

The CLC control board supports a central control of the drives. One CLC can control up to 40 drives. The real-time communications system, SERCOS interface, is used to communicate between CLC control board and drives. The link between the CLC and the drives is established with the use of a fiber optic cable ring. The fiber optic cables are connected to optical transmitters and receivers on the control board and the DSS plug-in module in the drives.

A system, consisting of one CLC control board and the thereto connected drives, is identified below as a *SYNAX ring*.

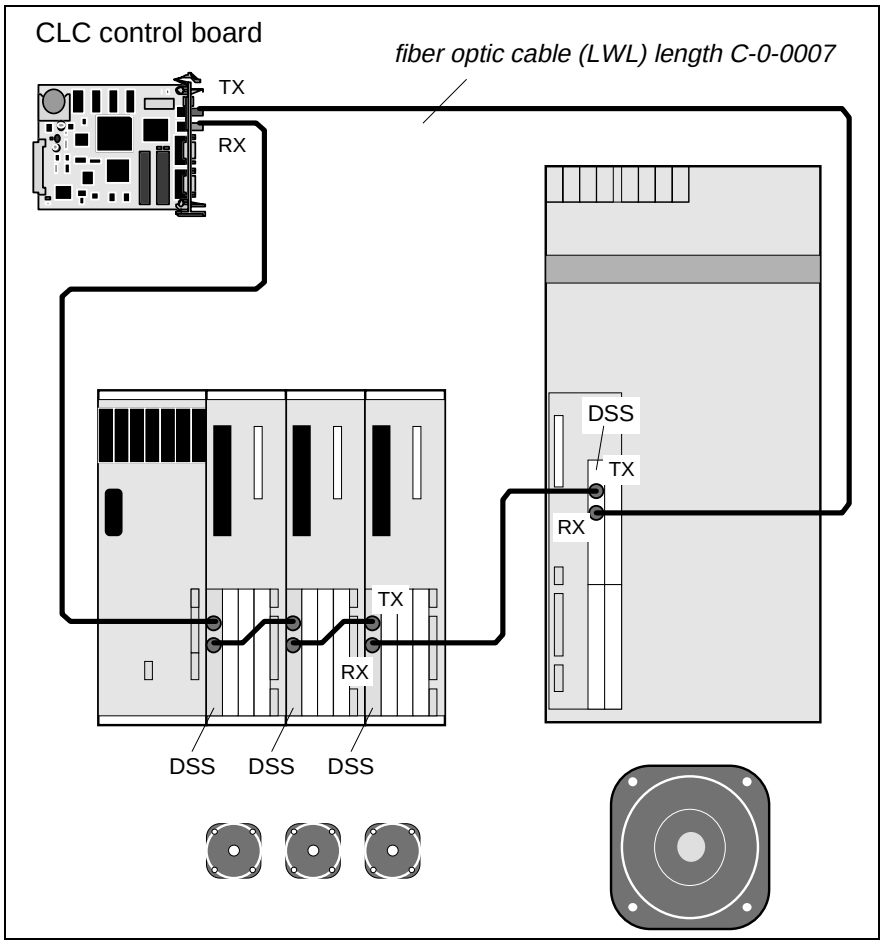


Fig. 12-1: SYNAX ring with four drives

Optical transmission power

Depending on the length of the fiber optic cable, it may be necessary to adjust the optical transmission power.

Transmission power is set on the CLC control board via parameter "fiber optic cable (LWL) length" (C-0-0007). The length set here refers to the length of the fiber optic cable between the transmitter of the CLC (X25) and the physically first drive within the ring.

Transmission power can be set on the drive with the use of switches on the DSS

Note: The output power set at the factory can generally be retained.

Transmission rate

- in preparation -

12.2 Drive administration

Projected drives

Each drive within the SYNAX ring has its own address. The drive address is set at the address switch on the DSS plug-in module in the drive. Any address within a range of 1 to 40 can be set.

The address switches are read in during initialization of communications (communications phase 1: 'P1' on the drive display) between the CLC and the drives. Communications phase 1 is run through when powering up and when switching from operating into parameter mode.

The addresses of all the drives within the SYNAX ring are entered in any order in the CLC parameter "addresses projected drives" (C-0-0002). This address list is used by the CLC to identify the drives.

Deactivating a defective drive

Running production should not be interrupted, if possible, even if a drive fails. If it is technically possible to do without the defective drive, then it can simply be deactivated without any technical demands (replacement of unit, accessing the fiber optic cable ring).

A drive is deactivated with the help of parameter "drive deactivation" (A-0-0006).

A-0-0006 = 00000000 00000000: drive activated

A-0-0006 = 00000000 00000001: drive deactivated.

It is necessary to switch the SYNAX ring into initialization mode for this reconfiguration. The list of "addresses projected drives" (C-0-0002) is not changed.

For diagnostic purpose the list of all deactivated drives can be read from parameter "addresses deactivated drives" (C-0-0086).

Deactivated drive

A deactivated drive is not switched into operating mode. It remains in phase 0...2.

Plug-in module in deactivated drives

The CLC does not address deactivated drives. This means that functions that access a plug-in card in a deactivated drive will not operate properly.

Examples:

- binary I/Os (DEA)
- analogue inputs (DAE)
- real master axis (e.g. DFF).

Note: The binary outputs of a deactivated drive (e.g., "drive ready to operate", _A:F#.02) are not emulated.

Checking the drive configuration

When running up the system, the CLC checks drive projection. The addresses of the drives within the ring are read in and compared with the entries on the list of "addresses projected drives" (C-0-0002) and "addresses deactivated drives" (C-0-0086). If there is a contradiction between the parametrized projection and the physical ring configuration, then it will not be possible to run up the system. The CLC will issue an error message.

The results of the drive check are stored in two parameters:

- The addresses of the recognized drives are entered in the list "addresses recognized drives" (C-0-0087).
- The addresses of those drives that can actively participate in operations, are stored in the list "addresses operatable drives" (C-0-0088).

12.3 Parameters

The following is a list of the systems parameters relevant to the SYNAX ring. For details see "SYNAX Parameter Description".

Parameter number	Designation
C-0-0002	Addresses projected drives
C-0-0007	Fiber optic cable (LWL) length
C-0-0086	Addresses deactivated drives
C-0-0087	Addresses recognized drives
C-0-0088	Addresses operatable drives
A-0-0006	Drive deactivation

Fig. 12-2: System parameters in the SYNAX ring

13 System with multiple CLC controls

13.1 Introduction

The CLC control card cyclically transmits master axis positions to the following axes in the SYNAX ring. **One** CLC administers **one** master axis with a maximum of 40 following axes. Numerous applications can be accomplished with only one SYNAX ring. There are, however, other applications which necessitate a more complex ring.

Multiple master axes

Several master axes are defined for one machine, e.g., the folders of a printing machine. The following axes are hereby assigned to any of the master axes.

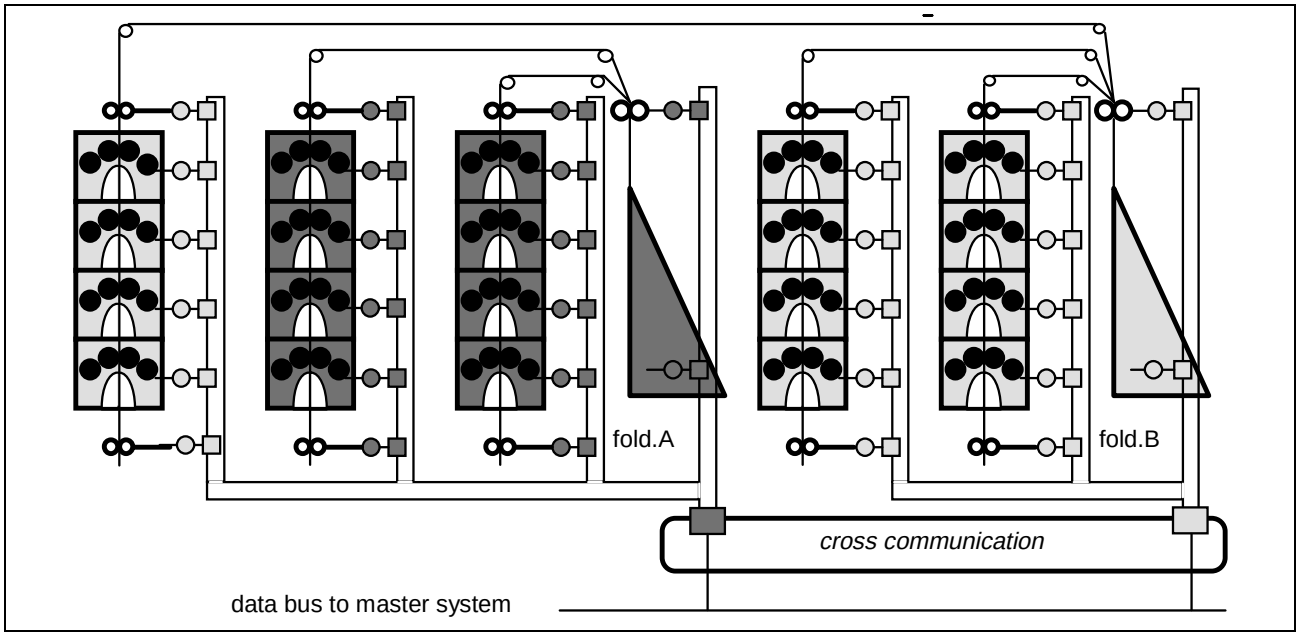


Fig. 13-1: Printing machines with two master axes - section oriented topology

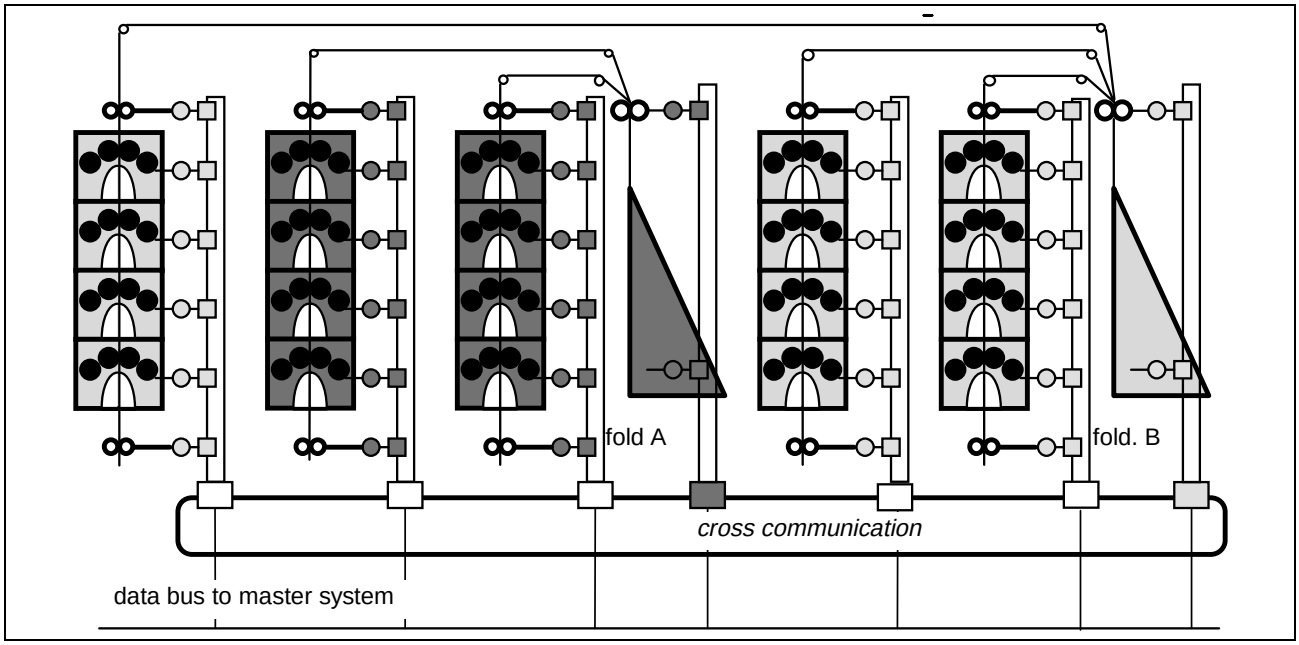


Fig. 13-2: Printing machine with two master axes - assembly oriented topology

Modular machine design

If a machine is modular in design, then a finishing station is allocated to each SYNAX ring. All the axes of a machine must follow the same master axis.

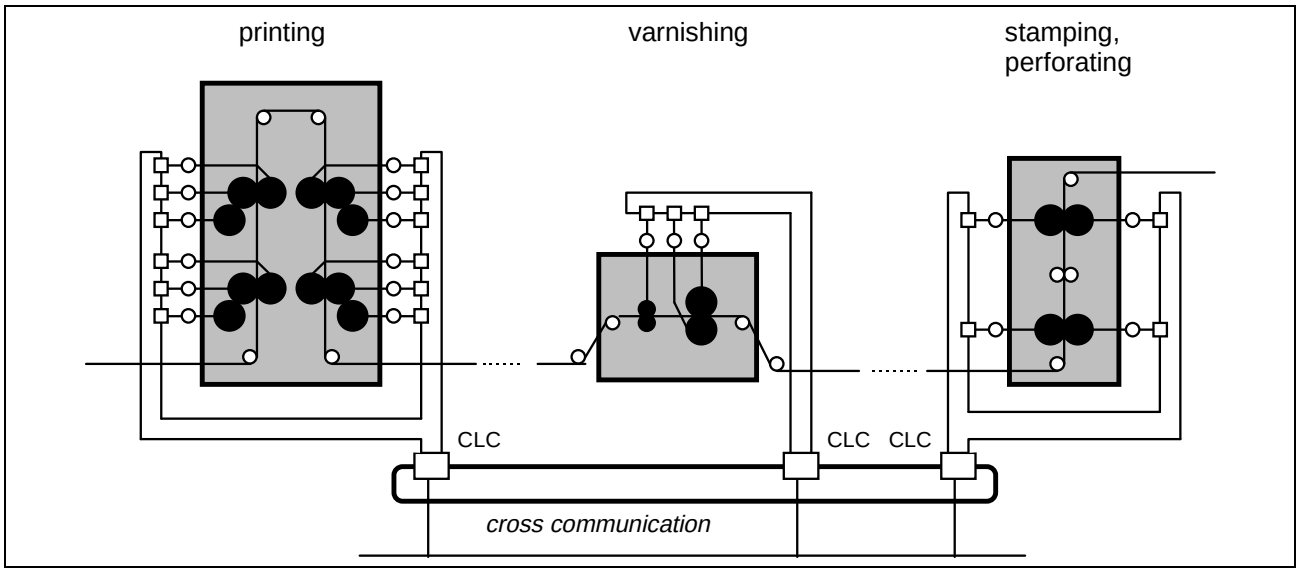


Fig. 13-3: Modular system with several SYNAX rings

High system capacity

The number of projected axes or the required range of functions (numerous real time functions such as register control) cannot be administered by one CLC. The following axes are distributed over several SYNAX rings, but must follow the same master axis.

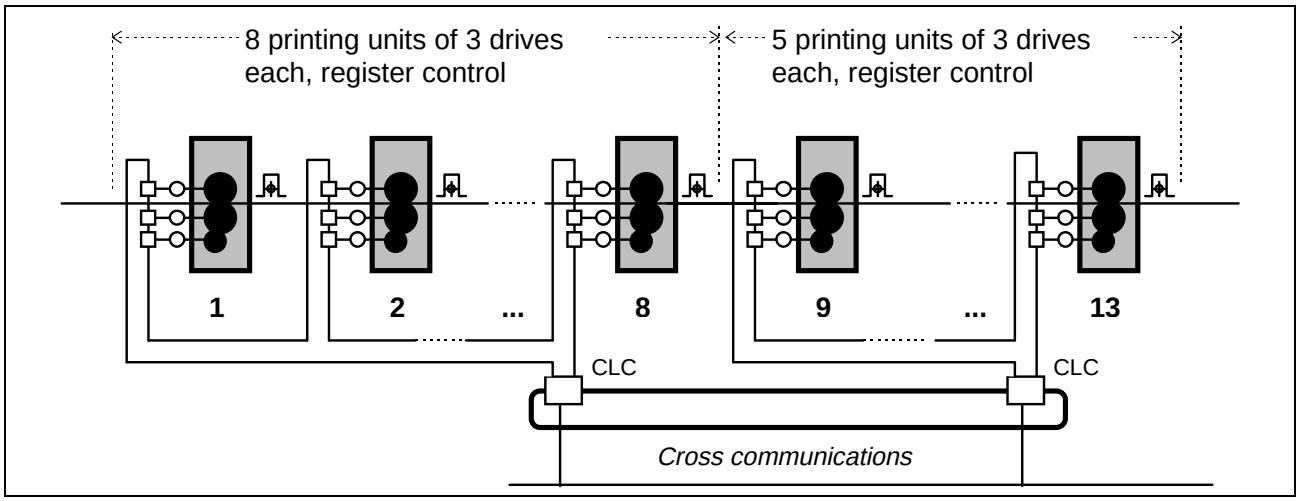


Fig. 13-4: Example of high system capacity

13.2 The CLC link

In order to be able to distribute the master axis positions of various CLC controls to any following axis in the SYNAX ring, it is necessary to combine the CLC controllers into one CLC link. The cross communications capability within the CLC link makes it possible to distribute the master axes positions to all following axes in various rings.

Hardware configuration

The interconnection of the CLC controllers is performed with the help of a *DAQ,* a daughter board. All DAQ assemblies are interconnected by means of one fiber optic ring thereby creating the CLC link.

Maximum of 32 CLCs in a link

Up to 32 CLC controls can be interconnected to create a CLC link.

Single or double fiber optic cable ring

The CLC link can implement either a single or a double fiber optic cable ring.

The double ring offers

- an increased error tolerance, i.e., a failure in the transmission stretches between CLCs will be tolerated
- and there is increased availability, i.e., even if the control is shutdown, cross communications with the remaining SYNAX ring can still be maintained.

CLC link with single ring

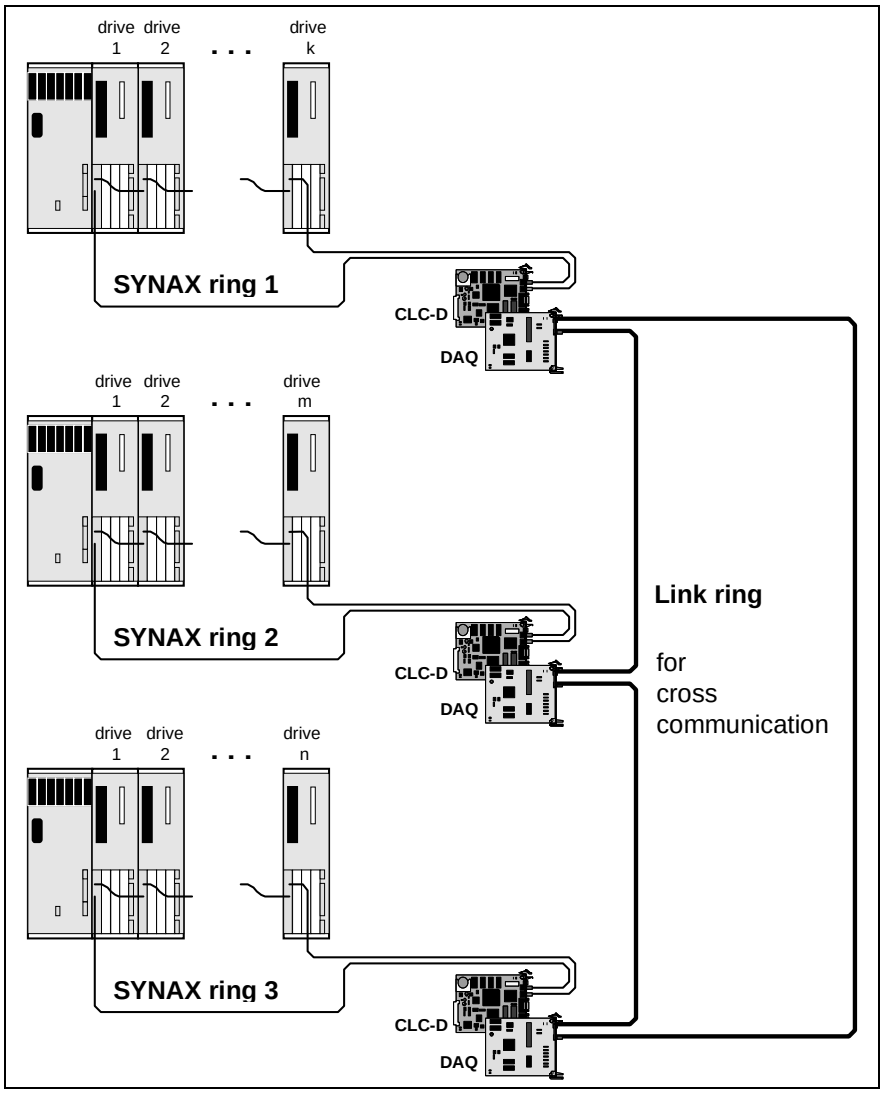


Fig. 13-5: CLC link with single ring

Optical output power

Depending upon the length of the fiber optic cable within the link ring, it may be necessary to adjust the optical output power.

The output power is set in parameter "CLC link - Fiber optic cable (LWL) length" (C-0-0103). The length set here refers to the length of the fiber optic cable between two adjacent DAQ boards.

CLC link with double ring

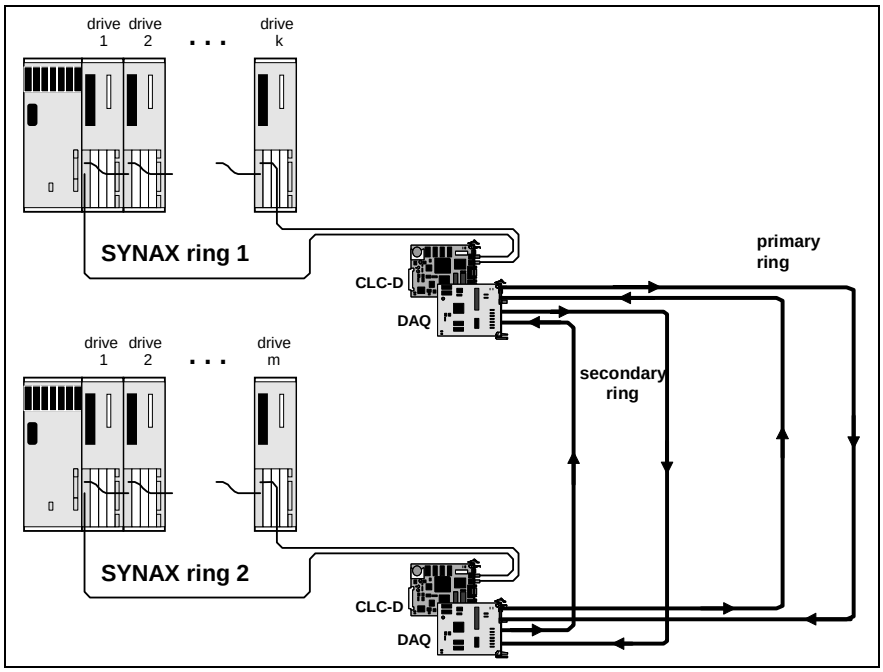


Fig. 13-6: CLC link with double ring

The double ring has a redundant fiber optic ring. Data is transmitted on it in the opposite direction.

Primary and secondary rings

A differentiation is made between the secondary and primary rings. Normally, only the primary ring is used for communications while the secondary ring remains a redundant, passive backup ring.

Reconfiguration

In the event of an error, the ring is automatically reconfigured so that there is no break in communications.

Optical output power

Primary ring output power is set, as with the single ring, in parameter "CLC link - Fiber optic cable (LWL) length" (C-0-0103). Secondary ring power is set with parameter "CLC link - Fiber optic cable (LWL) length secondary ring" (C-0-0109).

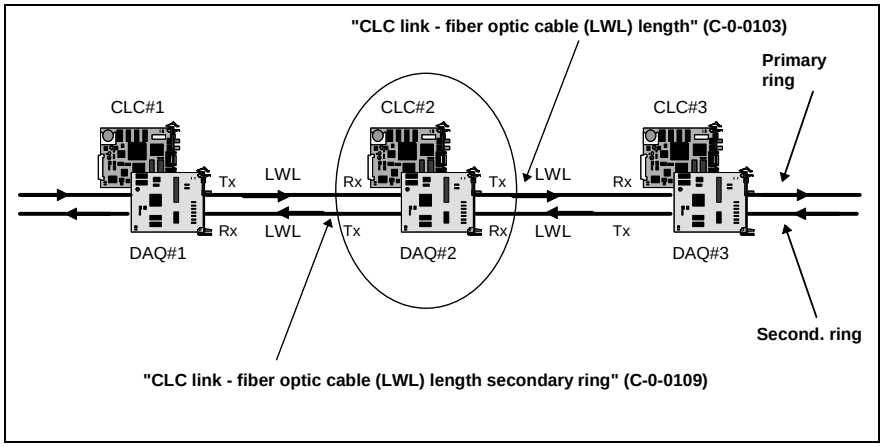


Fig. 13-7: Parameter "fiber optic cable lengths" with a double ring

13.3 Configuring the link participants

Communications in the CLC uses a fiber optic ring as does the SYNAX ring.

Link address

Each link participant has a link address. The link address is set via the address switch on the DAQ board. The set address is read in ***once*** after the CLC is switched on.

Note: The link address must be within the range of 1 to 32. Gaps in the addresses are permitted.

With respect to its function in cross communications, the CLC control board acts as

- a link master,
- link slave or
- it remains passive.

The configuration of a CLC as link participant is set in parameter "CLC link - control word" (C-0-0102).

C-0-0102, Bit 1	C-0-0102, Bit 0	Behavior of the CLC in the link	Function of the CLC in the link
1	1	active participant	link master
0	1	active participant	link slave
x	0	passive participant	repeater

Fig. 13-8: Configuration of the link participant

One (1) link master

There must be exactly one link master in the CLC link.

Maximum of 31 link slaves

One link master can administer a maximum of 31 link slaves. There may be any number of passive participants.

Note: Since all link participants synchronize their telegram processing in terms of the link master, all drives within this SYNAX ring work synchronously. This also applies to the control algorithm in the drives.

Link master

The link master controls cross communications. It controls the cycle time in all SYNAX rings that participant in the CLC link via a link slave function. The link master collects and distributes the master axes positions cyclically to all slaves within the link.

Link slave

A link slave forms a link connection to the fiber optic cable ring of the CLC link. It synchronizes telegram processing of its SYNAX ring with cross communications.

Passive participant

Those slaves who are integrated into the LWL ring of the CLC link, but are not parametrized as active participants of it, remain passive. This means that they merely transmit the signal arriving at their input onto their output (repeater function). They do not participate in communications.

13.4 Single - double ring configuration

The DAQ board DAQ02 supports both the double and single ring.

Single ring: Primary ring

Only the primary ring is used with the single ring. The secondary ring is not cabled.

Double ring: Primary and Secondary rings

In the case of a double ring, both the primary and secondary rings are used in the cross communications process.

Configuring a DAQ as single or double ring participant is done in parameter "CLC link - control word" (C-0-0102).

C-0-0102, Bit 4	Participant type
0	single ring
1	double ring

Fig. 13-9: Configuration as a single or double ring participant

Note**:** All link participants must have the same single/double ring setting.

13.5 Master axis configuration

Each CLC in the CLC link administers one master axis. The master axis position is standardly transmitted by the CLC to all of the following axes in ist own SYNAX ring.

Allocating any following axis to master axes

Within the CLC link, up to 32 master axes can be active (maximum of 32 link participants). Each following axis can be assigned to any master axis within any SYNAX ring. The following axes of a SYNAX ring can either all follow one external master axis or they can be assigned to any master axis within the CLC link.

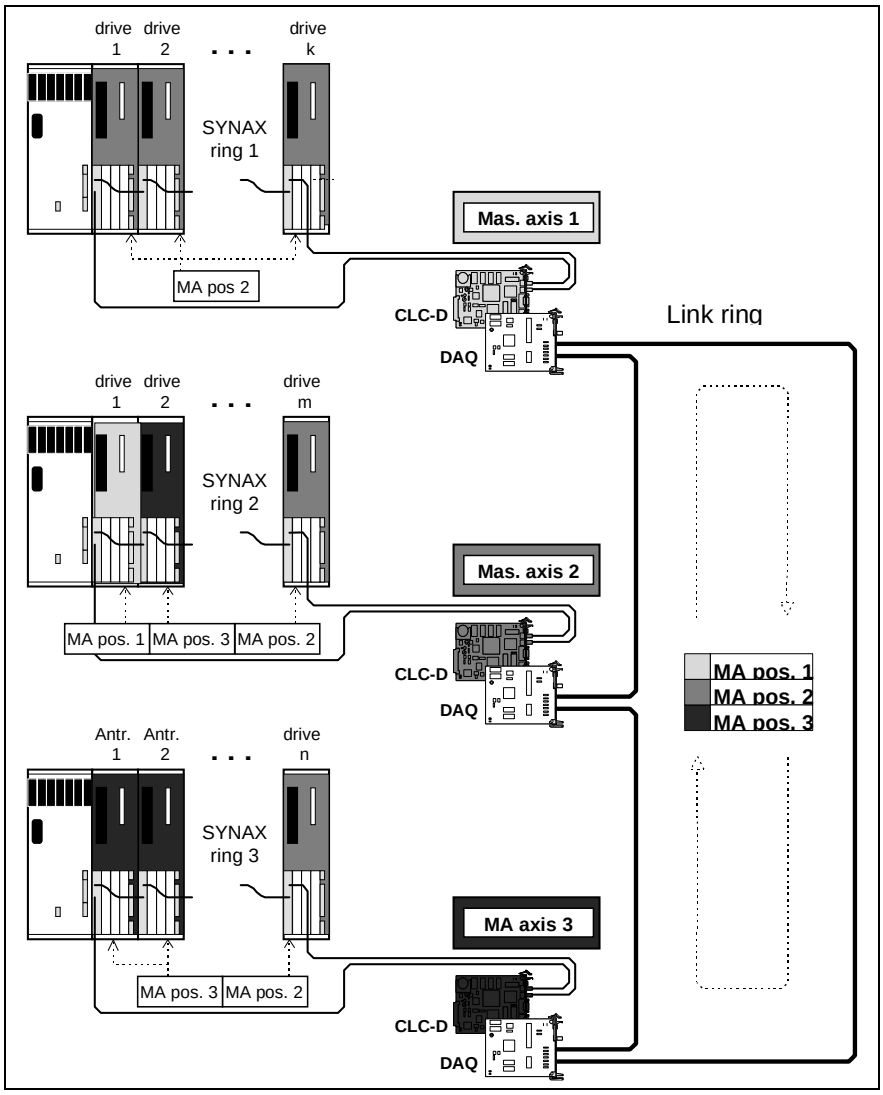


Fig. 13-10: Example of master axis configuration within the CLC link

Allocating a following axis to an external master axis within the CLC link is done via parameter "CLC link - master selection" (A-0-0104). The addresses of the master axis are entered in this parameter. The address of a master axis is the same as the link address of the CLC which is generating the master axis position. It applies:

Entry in A-0-0104	**Actual master axis position**
address nn	master axis position in the CLC with link address nn
intrinsic link address	master axis position of the CLC within its own SYNAX ring
default value ’0’	master axis position of the CLC within its own SYNAX ring

Fig. 13-11: Allocation of the master axis

If a CLC is not configured as a link participant, then the following axes in this SYNAX ring are automatically allocated to their own master axis. Parameter A-0-0104 is not effective.

Note: The allocation following axis ↔ master axis can be changed in operating mode. Before changing A-0-0104 it is necessary to cancel the "drive enable" signal.

13.6 Binary outputs in the link

Communications via the CLC link fiber optic cable ring are monitored by all link participants. Errors and system states are signalled via the system outputs listed below:

Designation	Function
_A:C01.04	CLC link error
_A:C01.05	CLC link - error primary optical ring
_A:C01.06	CLC link - error secondary optical ring
_A:C01.07	CLC link - redundancy loss
_A:C02.01	link participant 1 - data valid
_A:C02.02	link participant 2 - data valid
_A:C02.03	link participant 3 - data valid
. .	. .
_A:C02.32	link participant 32 - data valid

Fig. 13-12: System outputs in the link

CLC link error (_A:C01.04)

This output is set if there is one of the following errors in the CLC link:

- several link master were configured
- the transmission of master axes positions has broken down due to telegram failures
- *only applies to cross communications with single LWL ring* - a break in the fiber optic cable has been detected.

CLC link - error primary optical ring (_A:C01.05)

This output is only relevant in redundant systems, i.e., during cross communications via a double ring. It is set if the link participant has detected a fiber optic cable break in the primary ring.

CLC link - error secondary optical ring (_A:C01.06)

This output is only relevant in redundant systems, i.e., during cross communications via a double ring. It is set if the link participant has detected a fiber optic cable break in the secondary ring.

CLC link - redundancy loss (_A:C01.07)

This output is only relevant in redundant systems, i.e., during cross communications via a double ring. It is set by each link participant if at least one signals a "CLC link - error primary ring" or "CLC link - error secondary ring".

Link participant .. - data valid (_A:C02.n)

Once cross communications is established in the link ring, outputs _A:C02.01 ... _A:C02.32 are set if

- participant *n* is in the ring
- the value sent by it is valid and
- the data received by particpant *n* are accepted as valid.

Example: If a drive in the SYNAX ring follows a CLC with link address ’4’ and the master axis of a CLC with link address ’12’, then output _A:C02.12 of CLC ’4’ must be evaluated.

13.7 Binary inputs in the link

Designation	Function
_E:C01.04	Clear CLC-link error
_E:C01.05	CLC-link - rebuild double ring

Fig. 13-13: System inputs in the link

Clear CLC-link error (_E:C01.04) Errors (_A:C01.04) can be cleared with this input.

Note: After a ring interrupt in the link with a single ring, it is necessary to restart the machine in phase 0.

CLC-link - rebuild double ring (_E:C01.05) This input permits a reconfiguration of the double ring during operations.

13.8 Parameters for the CLC link

The following are the system parameters relevant to the CLC link:

Parameter number	Designation
C-0-0093	Internal I/O: CLC inputs
C-0-0094	Internal I/O: CLC outputs 1
C-0-0102	CLC link - control word
C-0-0103	CLC link - Fiber optic cable (LWL) length
C-0-0105	CLC link - MDT error counter
C-0-0106	Internal I/O: CLC outputs 2
C-0-0109	CLC link - Fiber optic cable (LWL) length secondary rings
A-0-0104	CLC link - master selection

Fig. 13-14: System parameters for the CLC link

13.9 Single fault tolerance and diagnostics in the double ring

In contrast to a single ring, a double ring offers error tolerance in the form of a single error. The first occurring error is tolerated (single error safety).

Each participant in the link monitors its receiving channels in the primary and secondary rings. A fiber optic cable break in the receiving channel is signalled via a binary output by the affected CLC. Once this first error has occurred, then, without in any way affecting running operations, there is an automatic reconfiguration of the link ring. This is performed by re-routing the data over fiber optic cable connections that are still intact.

A no error situation

The following is a simplified illustration of a CLC link with five participants.

Given a no error situation, communication takes place on the primary ring while only a diagnostics signal for error detection is transmitted on the secondary ring.

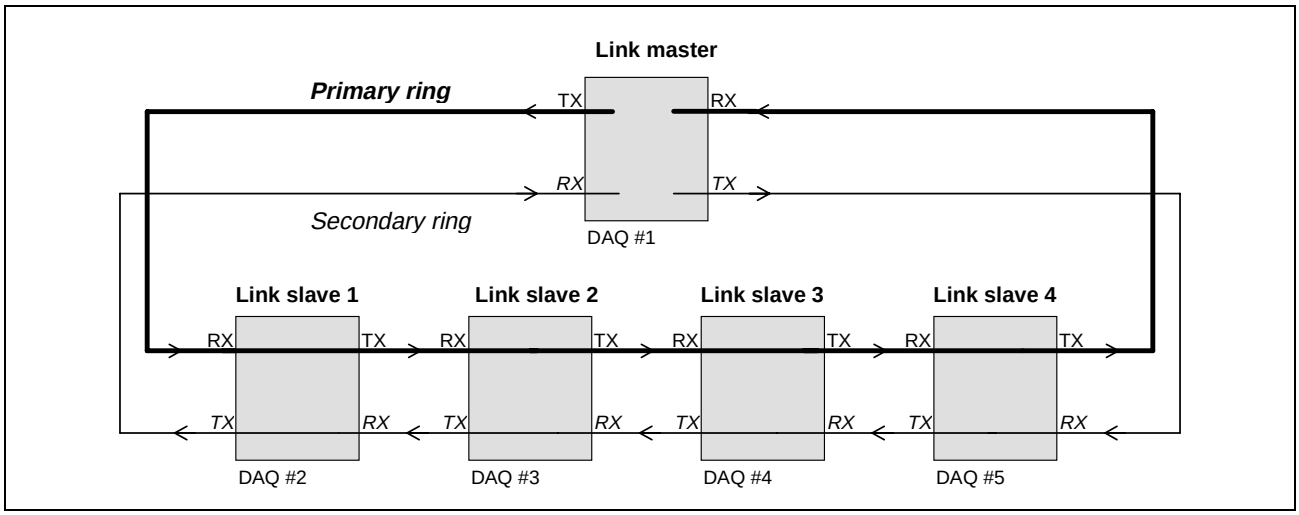


Fig. 13-15: The fiber optic ring in a no error situation

The following errors are differentiated:

- fiber optic cable break in the primary ring (simple error)
- fiber optic cable break in the secondary ring (simple error)
- fiber optic cable break in the primary and secondary rings between two adjacent link participants (double error)

The type of error and the location of the error can be clearly determined via the binary outputs of the CLC once the first error has occurred, viz.,

- if a link participant signals "CLC link - error primary optical ring" (_A:C01.05), then the fiber optic connection to the receiver in the primary ring of the participant is defective,
- if a link participant signals "CLC link - error secondary optical ring" (_A:C01.06), then the fiber optic connection to the receiver in the secondary ring of the participant is defective,
- if a double fiber optic break occurs between two link participants, then one of the participants signals "CLC link - error primary optical ring" (_A:C01.05), the other "CLC link - error secondary ring" (_A:C01.06).

Note: In the event of an error, all link partricipants signal "CLC link - redundancy loss" (_A:C01.07)..

Error in the primary ring

The example is a simple error between link slaves 3 and 4.

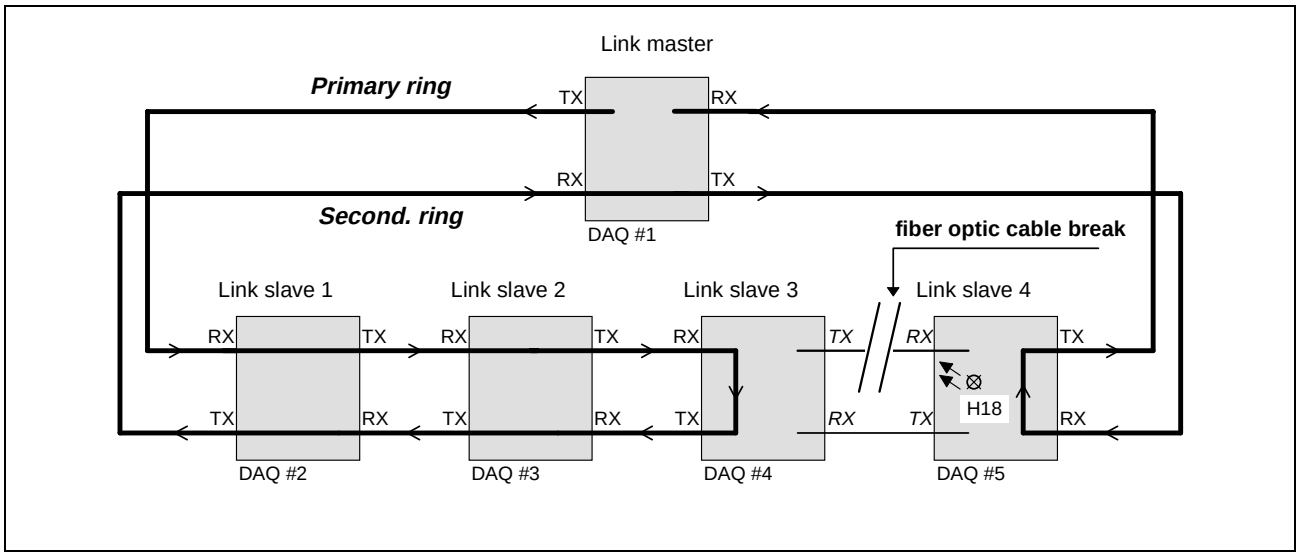


Fig. 13-16: Reconfiguration with a simple fiber optic cable break in the primary ring

Reconfiguration

Link slave 4 recognizes that the data signal is missing at its input in the primary ring. Slave 4 then switches its receiving channel to the input in the secondary ring. This switching process is detected by the adjacent participants (link slave 3 and the link master) and brings about an automatic rerouting of the data to the secondary ring.

Diagnosis

The fiber optic cable break is detected as an error in the receiving channel of DAQ #5 (slave 4).

- CLC #5 sets the binary output "CLC link - error primary ring" (_A:C01.05) = 1.
- The LED H18 (P) on DAQ#5 signals "error in primary ring".
- All link participants signal "CLC link - redundancy loss" (_A:C07) = 1.

Error in the secondary ring

The example here is a simple error between link slaves 3 and 4.

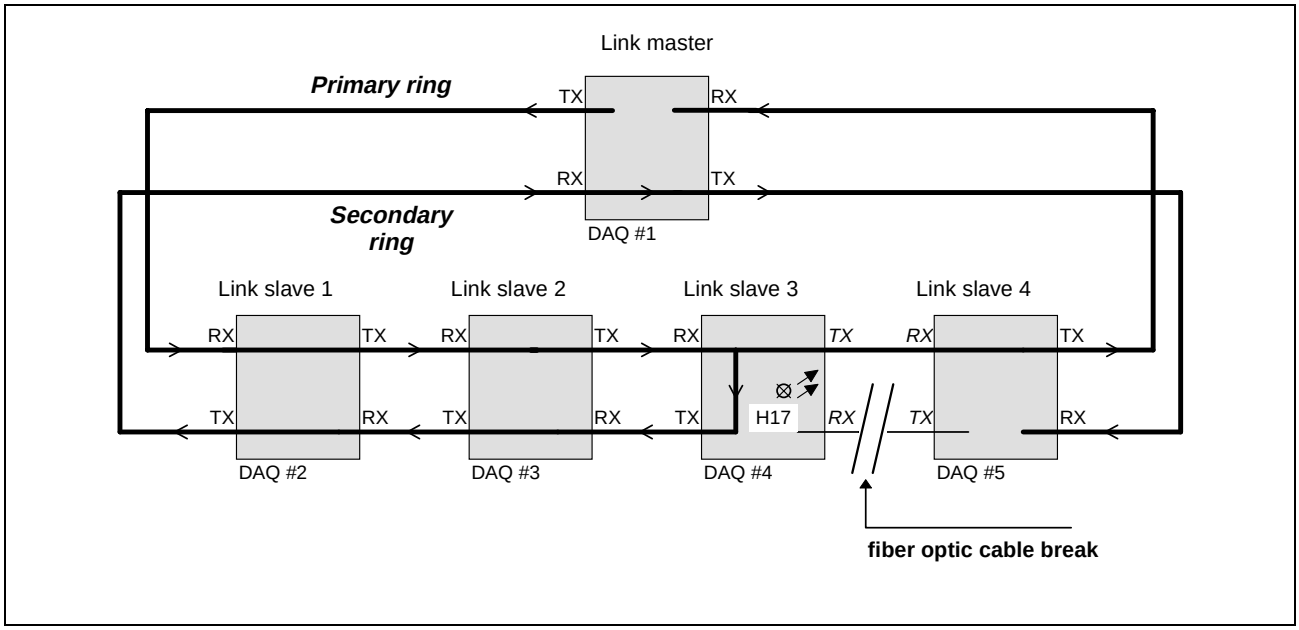


Fig. 13-17: Reconfiguration with a simple fiber optic cable break in the secondary ring

Reconfiguration

Link slave 3 recognizes that the diagnosis signal at one of its inputs in the secondary ring is missing. The slave then switches its receiving channel to the input in the primary ring. The second ring is separated and then drops off as a redundant system. The data are still transmitted via the primary ring.

Diagnosis

The fiber optic cable break is recognized as an error in the receiving channel of DAQ #4 (slave 3).

- CLC #4 sets the binary output "CLC link - secondary ring error" (_A:C01.06) = 1.
- The LED H17 (S) on DAQ#4 signals "error in secondary ring".
- All link participants signal "CLC link - redundancy loss" (_A:C01.07) = 1.

Double LWL break

The example depicts a double error between link slave 4 and the link master.

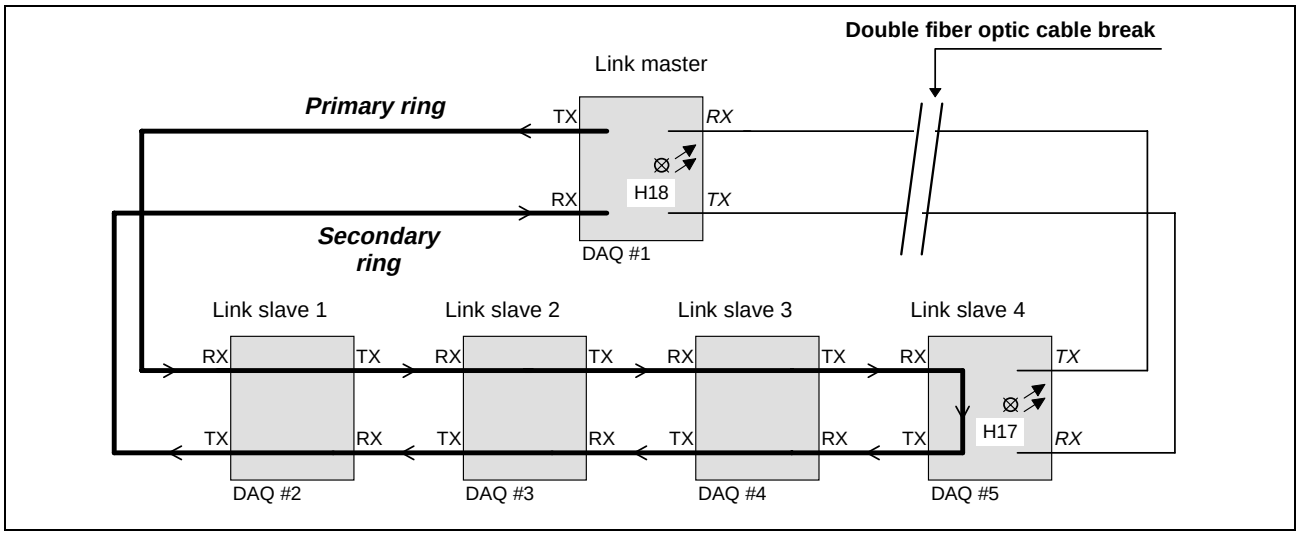


Fig. 13-18: Reconfiguration due to a double fiber optic cable break

Reconfiguration

Both the link master and link slave 4 detect the fiber optic cable break in the respective receiving channel. Both participants switch their inputs so that communications can be maintained via the secondary ring.

Diagnosis

The LWL break is recognized in the primary ring as an error in the receiving channel of DAQ1 (master). The interrupt in the secondary ring causes an error in the receiving channel of DAQ5 (link slave).

- CLC #1 sets the binary output "CLC link - error primary optical ring" (_A:C01.05) = 1.
- The LED H18 (P) on DAQ#1 signals "error in primary ring".
- CLC #5 sets the binary output "CLC link - error secondary optical ring" (_A:C01.06) = 1.
- The LED H17 (S) on DAQ#5 signals "error in secondary ring".
- All link participants signal "CLC link - redundancy loss" (_A:C01.07) = 1.

Reconfiguration to a double ring

After an break in the link has been repaired, then a reconfiguration on the ring structure as a result of the error can take place. This can be done by either

- stopping the machine and re-initializing via phase 0 or
- automatically reconfiguring in operating mode.

The automatic reconfiguration is actuated by setting the binary input "CLC link - rebuild double ring" (_E:C01.05). If reconfiguration was successful, then the binary error signals (_A:C01.05 ... _A:C01.07) are cleared.

Note: An external signal for automatic reconfiguration must be applied at all inputs of all link participants simultaneously.

13.10 Additive master axis command value in the CLC link

With the help of parameter "master axis command value additive" (C-0-0149) a phase shift for several axis can be synchronously conducted in contrast to the master axis (see section 2.4 "Additive master axis command value"). In the CLC link, this is also possible CLC overlapping.

Each CLC in the link can process a "master axis command value additive". Each "master axis command value additive" is acted upon at its offset speed (C-0-0150) on the relevant CLC and displayed for diagnostic purposes in parameter "master axis actual position value additive" (C-0-0160). *All* offset values are transmitted via the link ring to *all* link participants.

Via parameter "select master axis command value additive" (A-0-0159) it is possible to allocate any additive command value to each drive in the link.

Example:

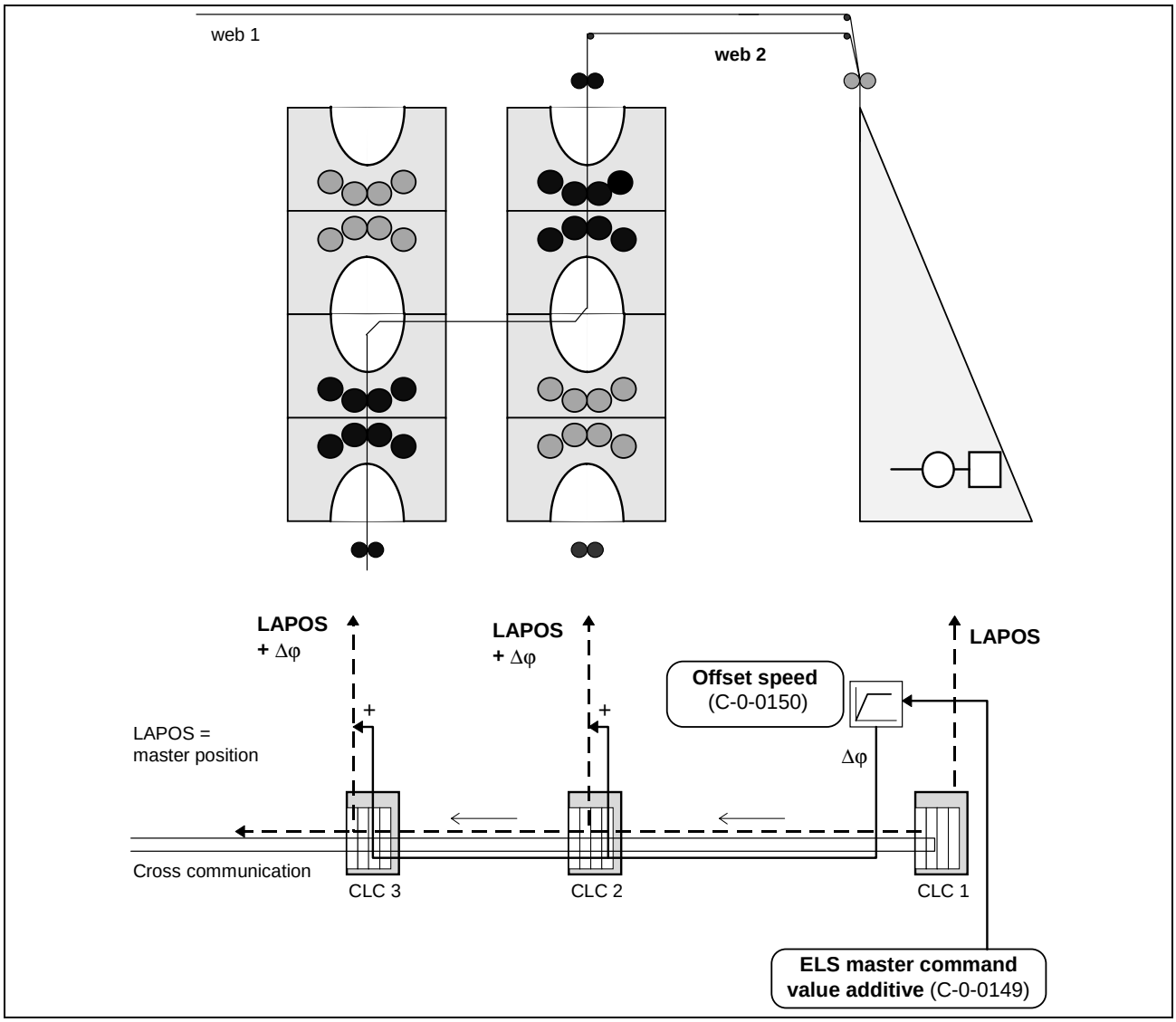


Fig. 13-19: Example of master axis command value additive in the CLC link

In the example the "master axis command value additive" is transmitted to the CLC with link address 1. The "master axis command value additive" is followed-up on the CLC 1 with "offset velocity" (C-0-0150) and transmitted via the link ring to link participants CLC 2 and CLC 3.

The additive command value should effect all the drives on web 2. In Synax rings 2 and 3 link address ’1’ must be entered for all relevant drives into parameter "select master axis command value additive" (A-0-0159).

In SYNAX ring 1 "master axis command value additive" has no effect. Parameter A-0-0159 is at ’0’ for all drives.

"Master axis command value additive" must be enabled on CLC 1 by setting the binary input "master axis command value additive - enable".

The effective offset is displayed on CLC1 in parameter "master axis position actual value additive" (C-0-0160).

The offset of a new command value is acknowledged by CLC1 via a binary output "ELS master command value additive achieved" (_A:L01.25).

13.11 Configuration Examples

Machine with modular construction

Three CLC controls have been combined to form one CLC link. Cross communication implements a single ring.

The control with link address ’2’ is configured as link master. The controls with addresses ’1’ and ’3’ work as link slaves. All axes must follow the master axis of the master (CLC 1).

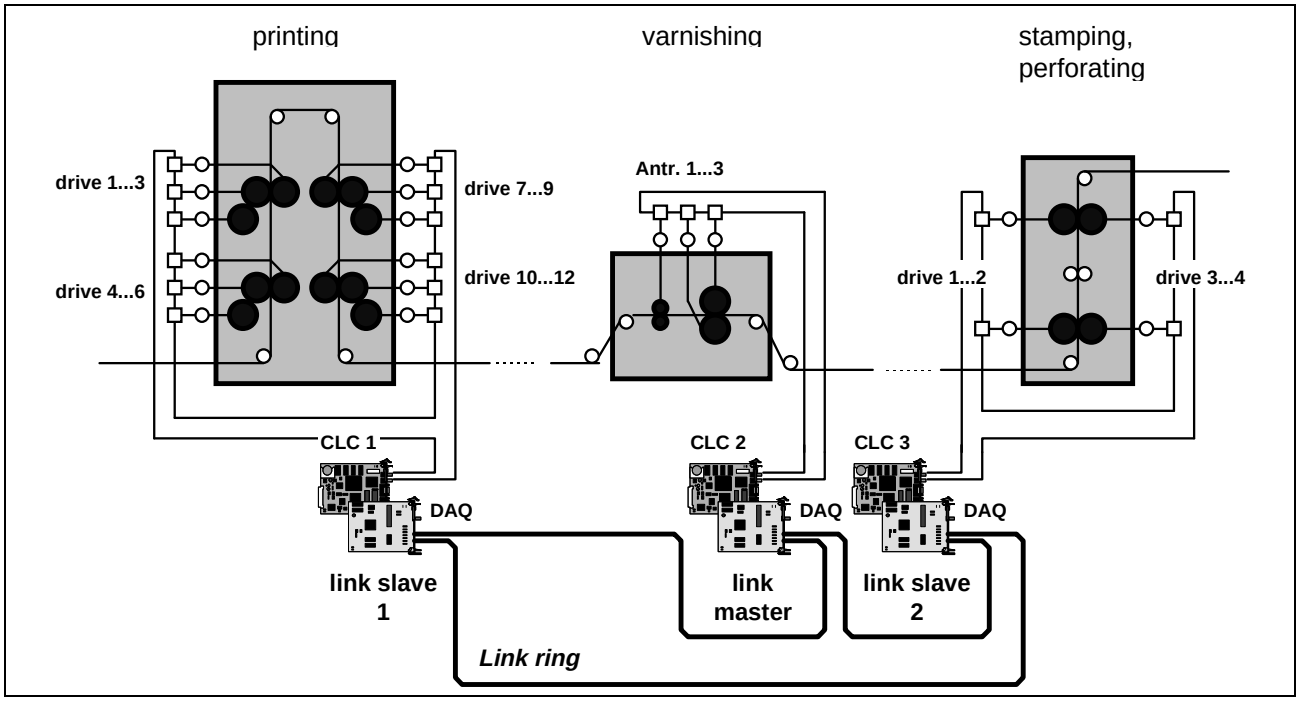


Fig. 13-20: Configuration example for modular construction

Single ring configuration

Bit 4 must be set to "0" in the "CLC link - control word" (C-0-0102) of all link participants.

Link partcipant configuraiton

The master/slave configuration of the CLC controls for the cross communications in the link is fixed with "CLC link - control word" (C-0-0102).

Link participant	"CLC link - control word" (Bit 4 = 0: single ring)
Link master (CLC 2)	00000000 000**0**00**11**
Link slave 1 (CLC 1)	00000000 000**0**00**01**
Link slave 2 (CLC 3)	00000000 000**0**00**01**

Fig. 13-21: Configuration example: 3 link participants in a single ring

Master axis allocation

The master axis of the CLC with link address "1" in parameter "CLC link - master selection" (A-0-0104) is allocated to all following axes in each SYNAX ring.

A-0-0104 = 1 for drives 1..12 in SYNAX ring 1

A-0-0104 = 1 for drives 1..3 in SYNAX ring 2

A-0-0104 = 1 for drives 1..4 in SYNAX ring 3

Rotary printer with two folding units

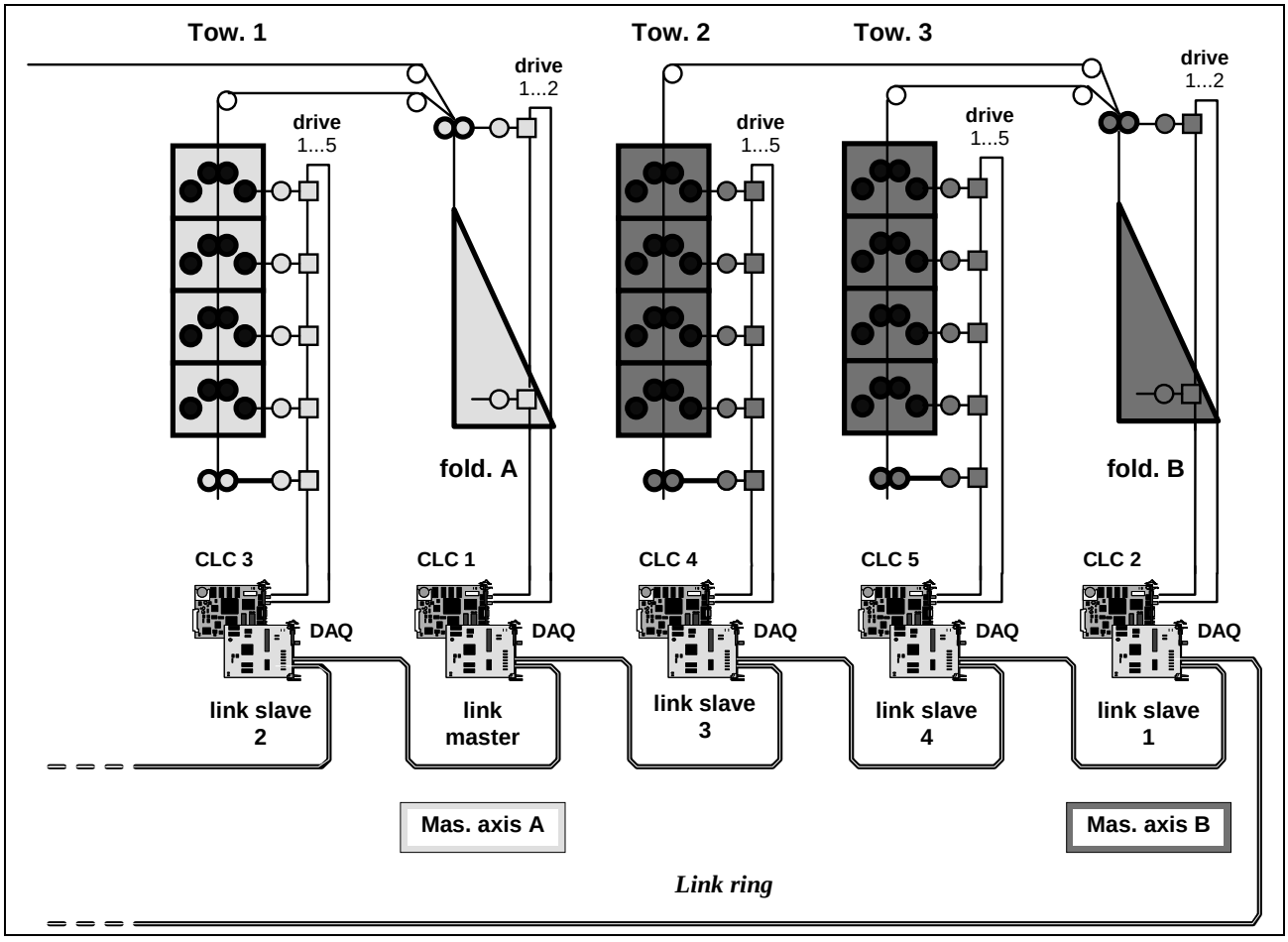


Fig. 13-22: Configuration example to the master axis link

Double ring configuration

Bit 4 must be set to "1" in "CLC link - control word" (C-0-0102) in all link participants.

Link participant configuration

With "CLC link - control word" (C-0-0102) the master/slave configuration of the CLC control for *cross communications* in the link is fixed.

Link participant	**"CLC link - control word" (Bit 4 = 1: double ring)**
Link master (CLC 1)	00000000 000**1**00**11**
Link slave 1 (CLC 2)	00000000 000**1**00**01**
Link slave 2 (CLC 3)	00000000 000**1**00**01**
Link slave 3 (CLC 4)	00000000 000**1**00**01**
Link slave 4 (CLC 5)	00000000 000**1**00**01**

Fig. 13-23: Configurations example: 5 link participants in a double ring

Master axis allocation

Printing tower 1 operates folder A, while towers 2 and 3 are allocated to folder B.

Folder A

Folder A and tower 1 operate synchronously, i.e., all axes participating in this procedure follow the same master axes. The master axis position is generated by the CLC allocated to the folder (master axis A). With the link address set on the DAQ - address "1" of the example - the master axis address is also set.

All following axes administered by CLC 3 (tower 1) and CLC 1 (folder A) are allocated to master axis "1" in parameter "CLC link - master selection" (A-0-0104).

A-0-0104 = 1 for all following axes in tower 1

A-0-0104 = 1 for all following axes in folder A

Folder B

Towers 2 and 3 operate synchronously with folder B, i.e., all axes involved in this process follow master axis B. The master axis position is generated by the CLC allocated to folder B. With the link address set on the DAQ -- address "2" of the example -- the master axis address is also set.

All following axes administered by CLC 4 (tower 2), CLC 5 (tower 3) and CLC 2 (folder B) are allocated to master axis "2" in parameter "CLC link - master selection" (A-0-0104).

A-0-0104 = 2 for all following axes in tower 2

A-0-0104 = 2 for all following axes in tower 3

A-0-0104 = 2 for all following axes in folder B

Converting to an altered web path

All three printing towers are now to work only on folder B:

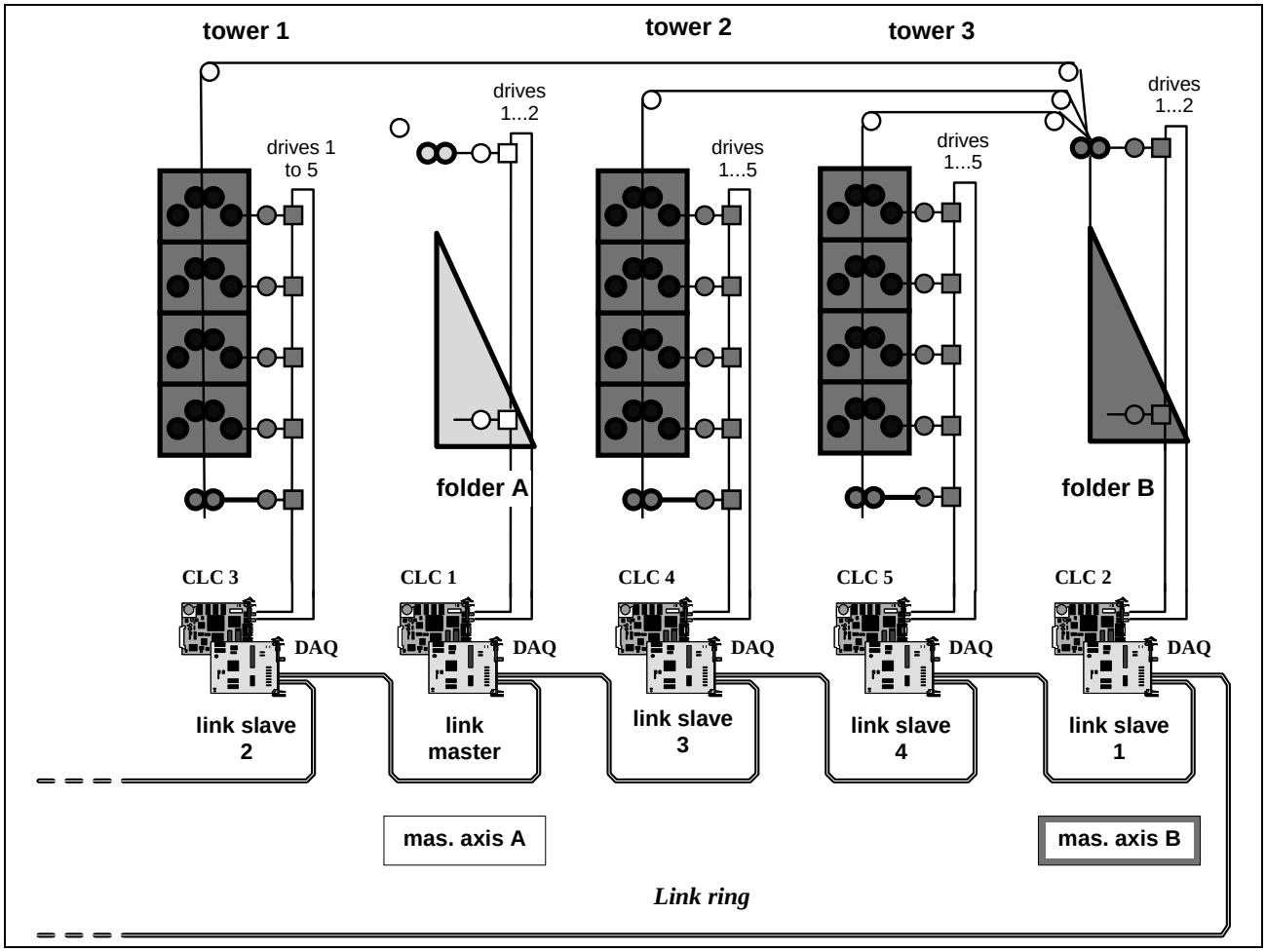


Fig. 13-24: Configuration example of master axis linking

Configuring link participants

The master/slave configuration of the CLC controls (C-0-0102) *for cross communications* remains unaltered.

Master axis allocation

All three towers now run synchronously with folder B, i.e., all axes participating in the new process follow master axis B.

All those following axes for which up until this point master axis "1" (folder A) had been selected will now be assigned to master axis "2" in parameter "CLC link - master selection" (A-0-0104):

A-0-0104 = 2 for all following axes in tower 1

The settings for towers 2 and 3 as well as folder B remain as they are.

14 Glossary

1MB

AC kit motor with water cooling for integration in spindles (inductance principles).

2AD

AC motors in power range of approx. 3.5 - 93 KW (inductance principle).

Absolute encoder

Encoders that supply an absolute position over several rotations (e.g., 4096).

ARCNET

Serial communication system (coaxial line).
If used with printing machines, for example.

CCD

Housing for CLC-D + daughter boards

CLC

Families of control cards with SERCOS interface. Available are CLC-P and CLC-D. Various software packages are available (here SYNAX).

CLC link

With the help of a SERCOS interface ring, up to 32 CLC-D controls can be connected. Master axis positions are synchronously distributed to all CLC-D's for this purpose.

CLC-D02

Plug-in control for DIAX03 drives and CCD box.

CLC-D03

Plug-in control for CCD box with external battery (requires two slots).

CLC-P01

PC plug-in control with ISA bus.

CLC-P02

PC plug-in control with PC/104 bus.

DAE

Analog input interface - plug-in module for digital drives.

DAG

SSI- EnDat encoder interface

DAQ

CLC link and/or ARCNET connection - CLC-D daughter board.

DBS

INTERBUS-S slave connection - CLC-D daughter board.

DEA

Digital 24V I/Os- CLC-D daughter board or plug-in module for digital drives.

DFF

High resolution master axis encoder interface - plug-in module for digital drives.

DIAX03

Controller family with an output width of 1 ... 100kW. (DDS02.2 / DDS03.2 / DKR02.1 / DKR03.1 / DKR04.1)

DIAX03 controller

Controller with uniform functions and a output band width of 1... 100kW. (DDS02.2 / DDS03.2 / DKR02.1 / DKR03.1 / DKR04.1)

DLF

High resolution sinusoidal encoder interface - plug-in module for digital drives.

DPF

Profibus slave connetion - CLC daughter board.

DSA

Master axis position with SSI signals - plug-in module for digital drives.

DSS

SERCOS interface - plug-in module for digital drives.

DZF

High resolution gear/tooth interface - plug-in module for digital drives.

GDS

Master axis encoder.

I/O logic

Simply logic with e.g. AND, OR, NOT allocations with which simply I/O allocations are executed.
The I/O logic is generated as a text file and translated. The results of this translation procedure are loaded into the CLC-D. A return to the original is not possible.

LAF

AC linear motor - flat construction (inductance principle).

LAR

AC linear motor - round construction (inductance principle).

LSF

AC linear motor - flat construction (synchronous principle)

LWL

Fiber optic cable, e.g., for SERCOS interface

MBW

AC mounting motor with hollow shaft for printing cylinders (inductance principle).

MDD

AC motor with digital servo feedback synchronous principle)

MKD

AC motor with resolver feedback (synchronous principle)

Multi-Turn

Encoder, that supplies an absolute position over several revolutions (e.g. 4096).

Select lists

Documentation used to determine, for a specific application, a specific motor/controller combination.

SERCOS interface

Internationally standardized digital interface (IEC 61491 or EN 61491) for communications between control and drives in numerically controlled drives.

Single-Turn

Encoder, that supplies an absolute position over a single revolution.

SSI

Synchronous serial interface. Interface for encoder systems with serial transmissions of digital actual values.

SYNAX

Decentralized System for the Synchronization of Machine Axes, made up of SYNAX firmware, SynTop software, CLC control, DIAX03 and ECODRIVE drives.

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engineering
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SYNAX

Decentralized System for the Synchronization of Machine Axes

Appendix A: SynTop

Indramat

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1 SynTop installation

1.1 General information on SynTop

SynTop is the SYNAX compatible and comfortable user interface running on a PC with MS-Windows. SynTop offers the following capabilities:

- Selective setup of all settings of SYNAX.
- Easy handling of SERCOS functions such as, for example, phase switching, setting absolute measurement or loading defaults.
- Function-specific setup of the drives of drive families
  - DIAX03 (from FWA-DIAX03-ELS-04VRS-MS) and
  - ECODRIVE (from FWA-ECODRV-SSE-02V07-MS).
  - DIAX04 (from FWA-DIAX04-ELS-05VRS-MS)
- Parameter blocks can be loaded and stored selectively .
- Various diagnostics possibilities at various levels
  - for the entire system
  - especially for a selected drive or
  - the CLC internal inputs and outputs.
- Context sensitive help system.

1.2 System prerequisites

SynTop requires MS Windows 3.1, Windows 95 or Windows NT and the following hardware components:

- 80486 processor or higher
- at least 8MB main storage
- at least 5MB free hard drive storage
- one free serial RS232 interface (COM)

1.3 The first steps with SynTop

Installing SynTop software

SynTop is supplied on CD ROM.

Observe the following steps to install SynTop:

- Read this complete chapter.
- Switch PC on and start Windows.
- SynTop CD ROM must be inserted into the CD ROM drive.

For Windows 3.1/NT 3.51

- Select the command "execute ...." in the menu "file".

For Windows 95/NT 4.0

- Select the command "execute ...." in the menu "start".

Note: If SynTop has to be installed on a PC which already has an older version on it, then this older version will be retained. The directory recommended by the installation program lists the version number as well as the icon of the program group. Already existing parameter files (in the directory "PARAM") must be copied into this new directory.
If an older version of SynTop has to be removed from the hard drive, then it suffices to erase the entire directory in which that "SynTop.exe" is located. This also applies to the relevant icon in the program group.

- Input D:\SYTP4V01\DISK1\SETUP into field "command line" (if the SynTop CD is in drive D:).
- Now follow the instructions of the installation program.

After completion of the installation procedure, the new program group INDRAMAT is on your PC. The SynTop program symbol and a symbol for the DIAX03 help system can be found in this group.

Connecting the PCs with SYNAX

RS232 interface

A connection cable is required for exchanging data between SYNAX and the PC. The ready-made cable, IKS061, can be ordered from INDRAMAT for this purpose.

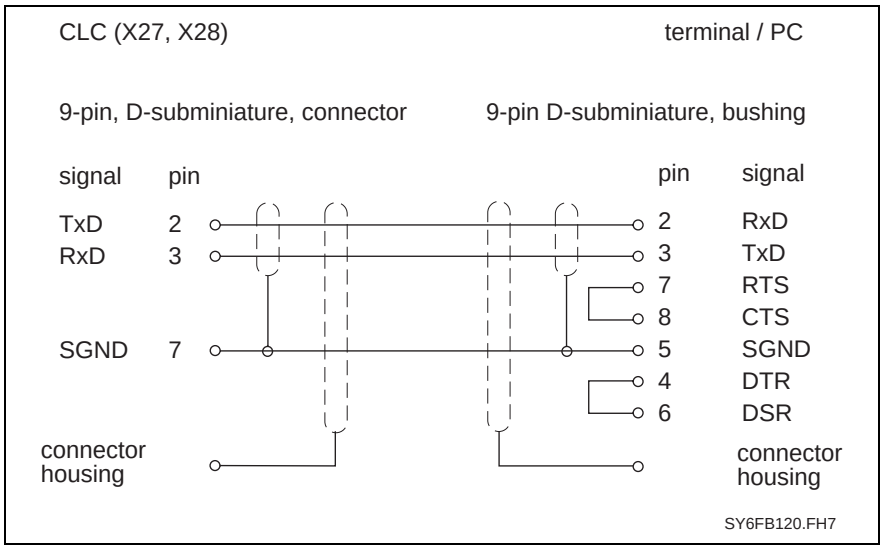


Fig. 1-1: Pin assignment - cable IKS 061 for connecting the PC via interface RS232 to the CLC

RS485 interface to multiple CLCs

With the help of the RS485 interface it is possible to link multiple CLCs via the RS485. The advantage here is that when starting up or for diagnostic purposes it is possible to access all CLCs from one PC equipped with SynTop without having to individually re-arrange the serial interfaces.

The structure of an RS485 interface in SynTop with multiple CLCs is displayed below:

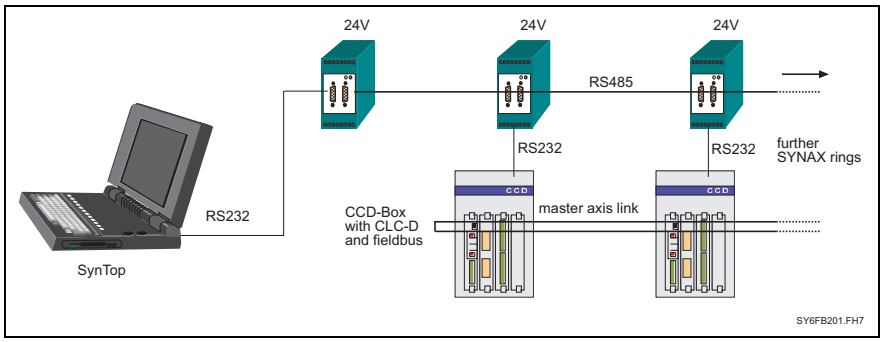


Fig. 1-2: RS485 interface

For more information on the RS232/RS485 interface converters, see the relevant Project Planning Manual.

Starting SynTop

General information

Prerequisites:

- The CLC as well as the connected drive controllers are mounted, electrically connected and have been tested.
- All drives with power and feedback cables have been connected to the drive controllers.
- The CLC is connected to all drive controllers via a fiber optic cable ring.
- SynTop has been installed successfully.
- The PC is connected to the CLC via the COM interface selected at the time of installation with the use of service cable IKS061.
- Jumper S1 or I5 (at CLC-P02) on the CLC is empty. Jumper S2 or I6 (at CLC-P02) is bridged. The connection X27 of the CLC is used for SynTop.

Interface / jumper settings

If X27 is needed at some later date for other purposes, then parameter "serial service interface - control word" (C-0-0104) must be reset before jumper S2 or I6 (at CLC-P02) can be removed.

Note: Functions can be assigned to the serial interfaces with the use of parameters. This excludes the use as a service interface, however.
To build up communications with the CLC operator interface, please note the following:

Jumper S1 or I5 (at CLC-P02) bridged, jumper S2 or I6 (at CLC-P02) empty
⇒ **CLC terminal interface signals at X27**

Jumper S1 or I5 (at CLC-P02) empty, Jumper S2 or I6 (at CLC-P02) bridged
⇒ **SynTop signals at X27**

Start SynTop in the INDRAMAT group of the program manager.

⇒ SynTop is started and attempts to construct a connection with SYNAX.

SynTop starts e.g., with the following structure:

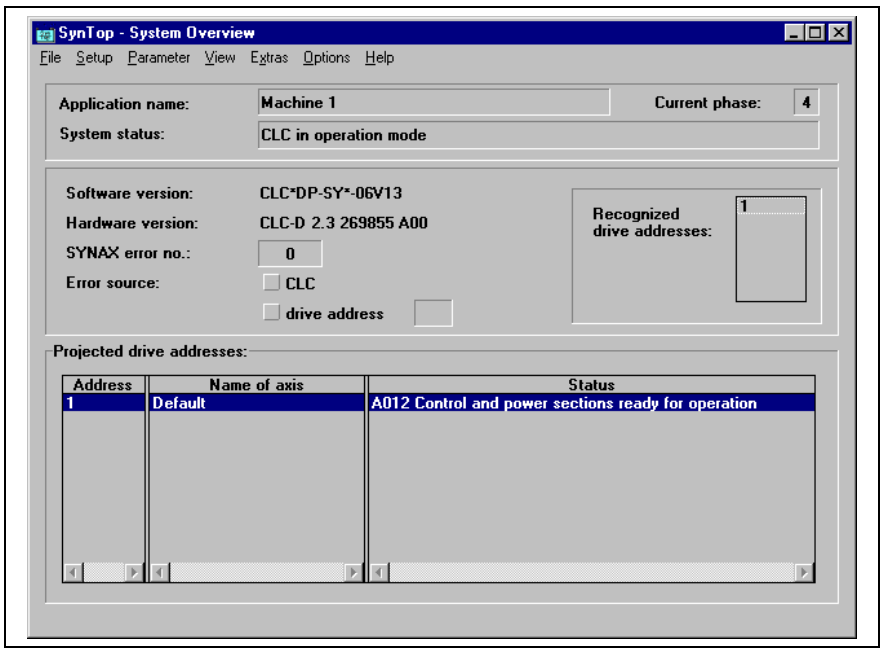


Fig. 1-3: Initial screen of SynTop

Note: After installation, COM1 or COM2, as a port, is set as an interface. If a different port is used, then no connection can be constructed. For clearing faults see "Fault clearance", page 5-1.

2 SynTop: Menu structure and functions

2.1 Main window

After starting SynTop, a main window of the plant status with status and diagnostics functions is displayed. In the list of projected drive addresses, a drive is selected by clicking the relevant line. The parameters in the dialog boxes will now reference this drive (see menu view).

Menu file

Fig. 2-1: Menu file

Submenu load

Parameters can be loaded into the drives or the CLC from a file.

Submenu save

The S/P parameters in the drives and the A/C parameters in the CLC are saved in a file.

Submenu load base parameters

The parameters of the CLC or drive are preset with default values.

Submenu I/O logic

The I/O logic of the CLC can be processed, compiled and loaded into the CLC.

Menu setup

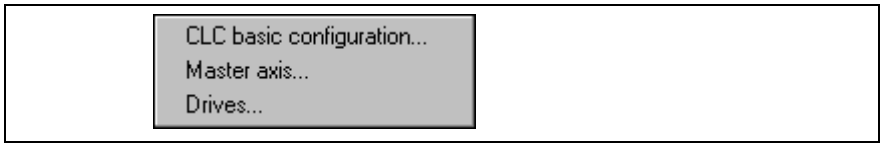


Fig. 2-2: Menu setup

The menu items "CLC basic configuration...", "master axis.." and "drives..." are located in the setup menu. If these items are called up, then the user runs through a series of dialog boxes to parametrize axis-independant C-parameters or axis parameters (A, S/P parameters).

Menu parameter

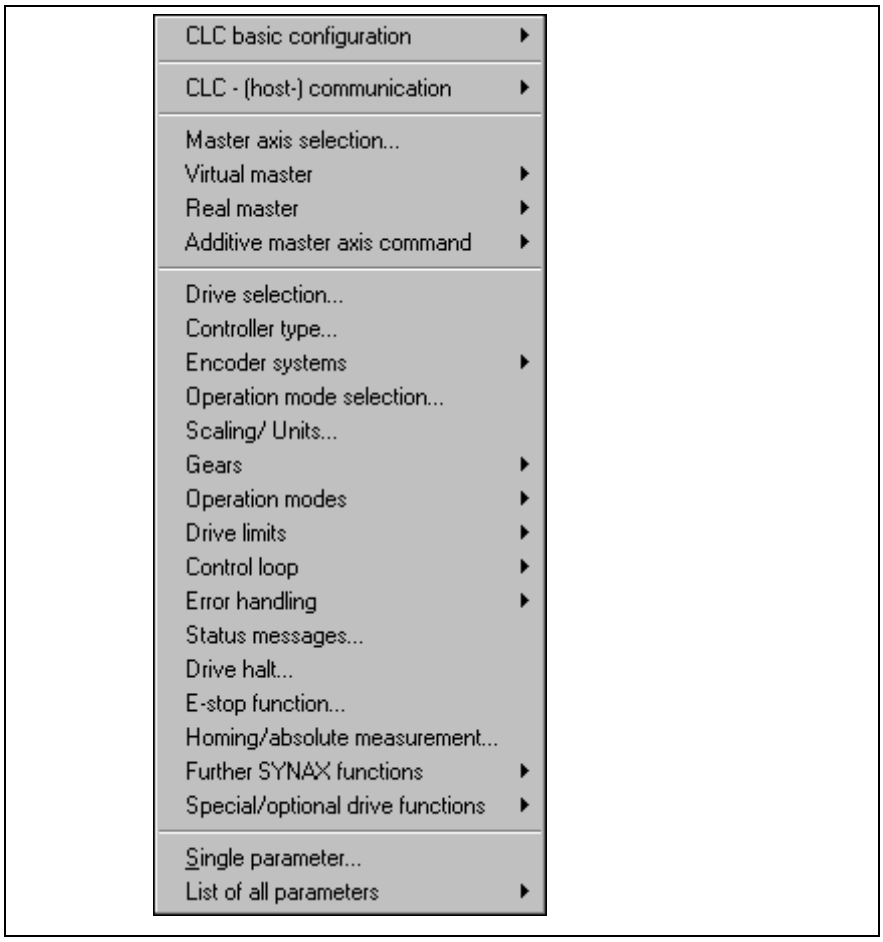


Fig. 2-3: Menu parameter

The menu parameter includes

- dialog boxes that are run through during setup,
- dialog boxes for individual parameters,
- dialog boxes with lists of all S/P, A or C parameters.

List of all parameters

The S/P parameters of the selected drive are listed with their name, operating data and unit. The user can sort these parameters according to ident numbers or alphabetically, search for a ident number or a text and change parameters.

Single parameter

A parameter of a selected drive address is listed by name, operating data, minimum and maximum value and unit. Enter the desired ident number and press <return>.

Menu view

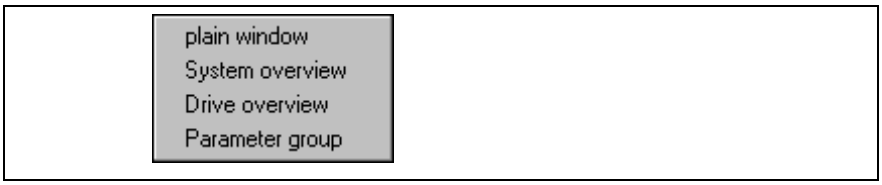


Fig. 2-4: Menu view

In the menu view, the diagnostics window displayed can be altered from

- system view,
- view of the selected drive in the system view
- the parameter group. The user can combine parameters to be displayed in any fashion.

Menu extras

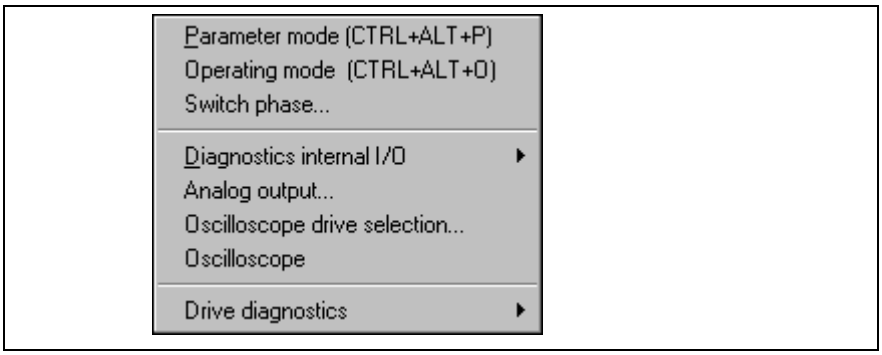


Fig. 2-5: Menu extras

In this menu are located

- menu items for phase switching ("parameter mode", "operating mode", "phase switching" modes),
- menu item "diagnostics" with submenus of the internal inputs and outputs,
- menu item "analog output",
- menu item for the oscilloscope function (with which at any time different signals to the drives can be recorded, visualized and compared)
- as well as dialog boxes for additional drive functions like "probe functions".

Menu options

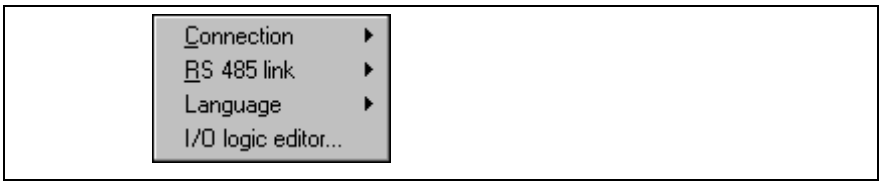


Fig. 2-6: Menu options

In the menu options there are the menu items "connections" (for switching online-offline), "RS485 link" (for setting the RS485 communication parameters), "language" (for switching German/English) and settings for the I/O logic editor.

Menu help

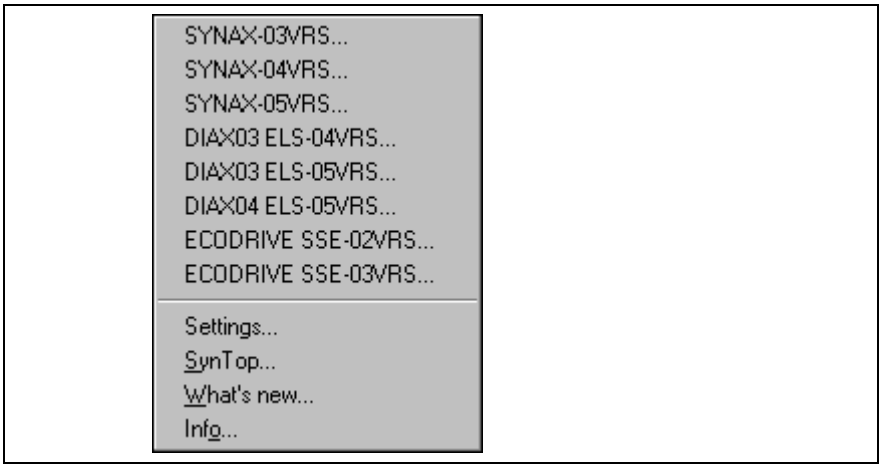


Fig. 2-7: Menu help (example)

Help systems for DIAX03, DIAX04 and SynTop and settings of help paths.

Note: This help is not a part of the SynTop installation. It must be installed seperately.

3 Structure of the parameter files

3.1 General

Storing parameters of the CLC, files with a structure described below are generated.

The parameter file is made up of one or several administrative sections and the data blocks (user files). In the parameter file, only ASCII-symbols with the IBM characters (MS-DOS) are used. Each line is closed with <CRLF>.

3.2 Administrative section of the parameter file

An administrative section of the parameter files is made up of six lines each is closed with <CRLF>.

The first line must contain "SERCOS-ASCII".

The fifth line contains the drive address set in the hardware of the drive. The drive address is made up of two symbols and must lie within the range of 01 to 99.

Lines 2, 3, 4 and 6 (free lines) are available to the user and can take a maximum length of 60 characters. If files from the CLC control card are stored, then the CLC bears the symbol <*> 12 times in each free line. If these free lines shall be used, then they can be programmed by the user at a later time.

3.3 Structure of the administrative section

SERCOS-ASCII

<free line>

<free line>

<free line>

<drive address>

The CLC generates the folllowing administrative section once the parameter file is stored.

3.4 Structure of the administrative section on the CLC

SERCOS-ASCII

CLC*DP-SY*-03V08

****

****

<drive address>

This administrative section can occur several times in a parameter file.

At the beginning of each

- block of A parameters for the axis
- block of S/P parameters for an axis
- block of C parameters there‘s such an administrative section located.

3.5 Data blocks of the parameter file

The data blocks are always made up of a pipe, the identification number, the name, the attribute and the operating data (parameter). Depending on the data type there can be a unit and a minimum and maximum input value.

Data block structure:

Element 0	|	[pipe, ASCII code = $(7C)_h$ or 124]]
Element 1	<Ident no.>	[see structure of ident number]
Element 2	<Name>	[Name of the operating data, maximum 60 char.]
Element 3	<Attribute>	[see attribute structure]]
Element 4	<Unit>	[Operating data unit, maximum 12 char.]
Element 5	<Min. input value>	[depicted like operating data]
Element 6	<Max. input value>	[depicted like operating data]
Element 7	<operating data>	[see structure op. data]
—		[Element in data block - not present]

Fig. 3-8: Data block structure

Identnumber structure

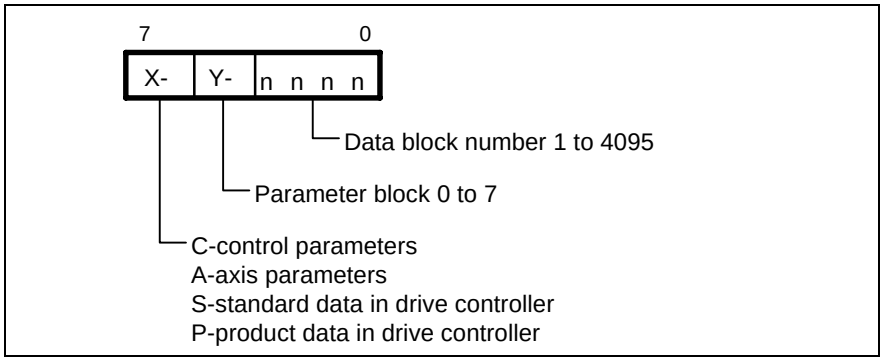


Fig. 3-9: Ident number structure

Attribute structure

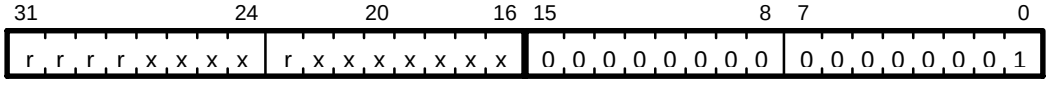


Fig. 3-10: Attribute Structure

Bit 15 - 0: Evalution factor

The evaluation factor is a qualifying signal for integers and must be set at 1.

Bit 18 - 16: Data length

0 0 0 - reserved

0 0 1 - Data is 2 bytes long

0 1 0 - Data is 4 bytes long

0 1 1 - reserved

1 0 0 - Data has a variable length of 1 bytes data

1 0 1 - Data has a variable length of 2 bytes data

1 1 0 - Data has a variable length of 4 bytes data

1 1 1 - reserved

Bit 19: Function

0 - operating data or parameter

1 - command

Bit 22 - 20: Data type and display format

Data type	display format
0 0 0 - binary number	binary
0 0 1 - without qualifying sign, integer	decimal without qualifying sign
0 1 0 - integer	decimal with qualifying sign
0 1 1 -without qualifying sign, integer	hexadecimal
1 0 0 - ASCII character	text (MS-DOS)
1 0 1 -without qualifying sign, integer	ident number
1 1 0 - reserved	
1 1 1 - reserved	

Bit 27 - 24: Decimal places

0 0 0 0 - no decimal places

...

1 1 1 1 - 15 decimal places (maximum)

Operating data structure

The operating data has a data length of either

- 2 bytes, 4 bytes or

- a variable length of 0 to 65532 bytes.

The length of operating data with variable length is given by the first two bytes.

The third and fourth byte carry the maximum length of the operating data made available by the drive or CLC respectively. The data starts with the fifth byte.

Example

Example of an administrative section:

SERCOS-ASCII
CLC*DP-SY*-03V08
****
****
01

Example of a data block 4 bytes long:

|
P-0-0061
angle offset start profile
00000100001000100000000000000001
degree
—
—

-38.000

Example of data block with variable length operating data:

|
C-0-0013
I/O - allocation internal/external I/O
01000000001101010000000000000001
--
--
--

01820	(actual length)
20000	(maximum length)
0x0007	PARA.EXE version number)
0x0000	PARA.EXE release number)
0x002E	(Offset of OPCODE)
0x6331	(start VKL file name:)
0x335F	(“c13-dea8.txt,“)
0x6465	
0x6138	
0x2E74	
0x7874	
0x2C20	
0x3039	(start of date VKL file:)
0x2E30	(“09.02.98,“)
0x322E	
0x3938	
0x2C20	
0x3137	(start of time VKL file:)

```
0x3A35          (“17:58,“)
0x382C
0x2043          (display selected HW platform)
0x4C43          (“CLC\h\o“)
0x0A00
0x7000          (start VKL instructions...)
0x7200
....
```

4 SynTop with RS485 link

Activating and setting up the RS485 link

Prerequisites

- SynTop starts correctly if only one CLC within the RS485 link has been switched on (RS232 connection).
- The parameters "SynTop - CLC address for RS485 bus" (C-0-0142) of all CLCs are set to their default value (address ’0’).

To start the RS485 link, each CLC is set to a unique RS485 address. Then the RS485 communication of the DDE server is activated.

Note: The following steps must be executed for each CLC individually. There is communication with each CLC individually, which is addressed with 0 (global address). All other CLCs have to be either switched off or their connection to the RS232/RS485 converter must be interrupted. Otherwise, data collision with the RS485 network could result.

Step 1: Switch on first CLC

The first CLC is switched on and SynTop is started.

Step 2: Setting the RS485 address of the CLC

The dialog "CLC settings" can be reached via the menu parameter.

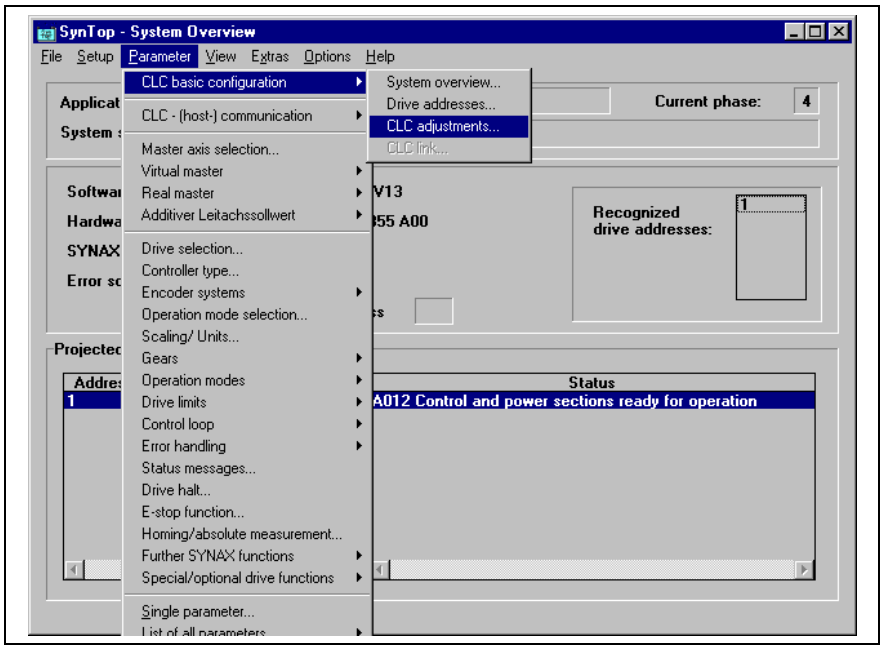


Fig. 4-1: Calling up dialog "CLC settings"

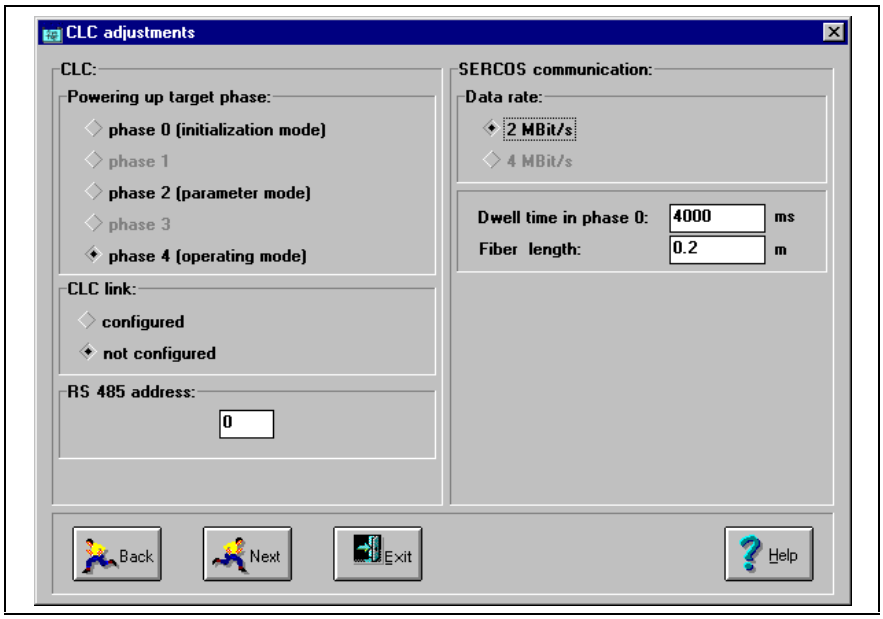


Fig. 4-2: Dialog "CLC settings"

In the field "RS 485 address" a unique address is set for the first CLC.

Note: The default value of the RS485 address is 0. When parametrizing the RS485 address, it must be greater than 0. Valid settings range between 1..255. Also, no two CLCs may have the same RS485 address as otherwise this could cause data collision on the RS484 network (SynTop link to CLCs is interrupted).

Step 3: Connecting with the next CLC

The connection to the current CLC is deactivated with
"Options"->"Connection"->"Offline"
The CLC is switched off or the link between the CLC and the RS232/RS485 converter is interrupted. The next CLC is switched on and the link from SynTop to the CLC estblished with
"Options"->"Connection"->"Online".

Step 4: Setting RS485 address of remaining CLCs

Steps 2 and 3 are executed for all other CLCs.

Now each CLC has a unique RS485 address.

Step 5: Activating RS485-communications

The next step is to activate RS485 communications with all CLCs.

Working with the RS485 link

Working as with RS232

The work with SynTop in the RS 485 link is done in the same way as with the RS 232 link. SynTop hereby communicates only with the selected CLC. The dialog to control the RS 485 link is placed in the menu options' -> 'RS 485 link':

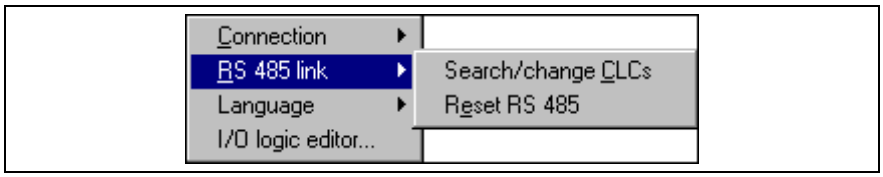


Fig. 4-3: Menu to RS 485 link

Changing between CLCs

To change the CLCs, use in menu 'Options' item 'CLCs search/change'. CLCs can here be searched for and selected.

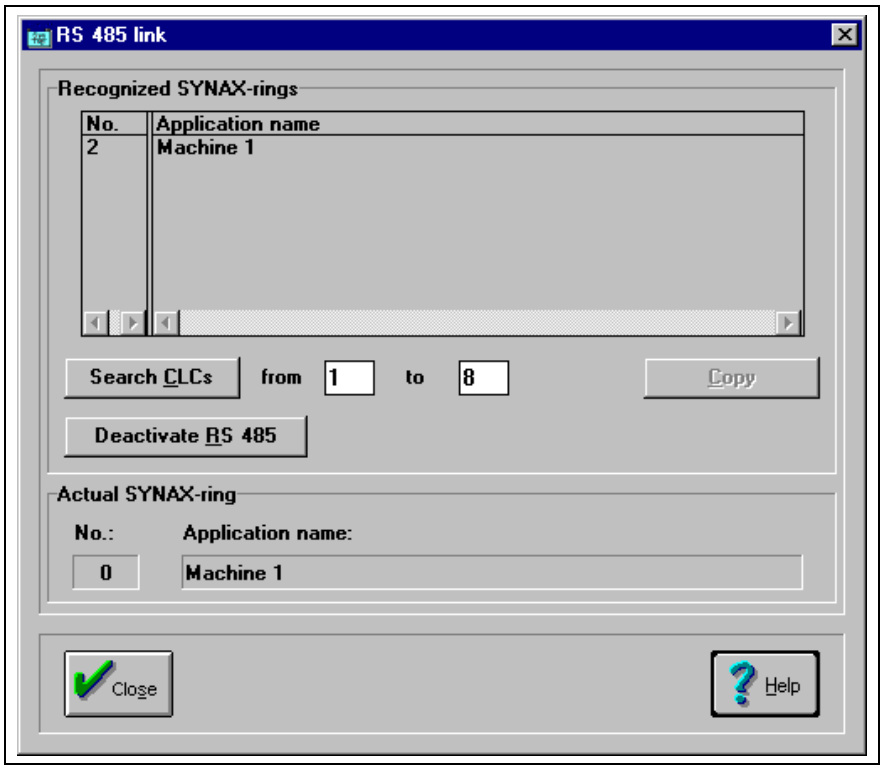


Fig. 4-4: Dialog 'CLCs search/change' (Example with 1 CLC)

Automatically searching CLCs

With the button 'CLCs search' it is possible to search for CLCs. It can take a few minutes if all addresses are being searched for (from 1 to 255).

Then any found CLC can be selected by choosing the relevant line in the listbox of the detected SYNAX rings and then selecting 'Copy'.

Using the 'Deactivate RS485' button, the CLC is switched to address "0". This only makes sense if only one CLC has been connected as otherwise all connected CLCs will respond.

Resetting RS485

SynTop 'notes' the found CLCs until it is restarted or to the next online. In the case of a machine change or a change in the switched on CLCs while SynTop is online, (e.g., a CLC is switched off or the RS485 address is changed), the list of found CLCs must be cleared. Otherwise, SynTop continues to address these missing CLCs in the RS485 dialog and the DDE server signals a communications error.

The list is reset with the help of

'Options' -> 'RS485 link...' -> 'RS485 reset'

Using the dialog 'CLCs search/change' the list can be rebuilt using 'CLC search'.

5 Fault clearance

5.1 Overview

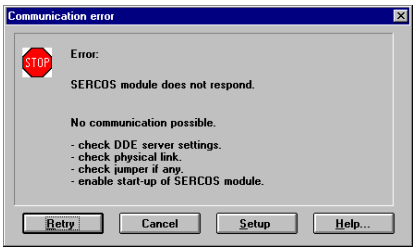
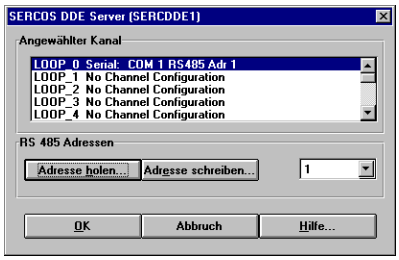
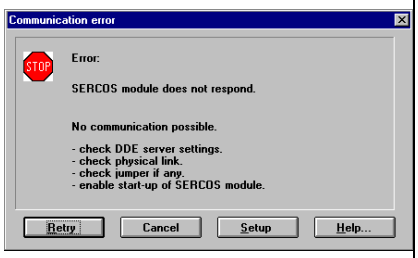
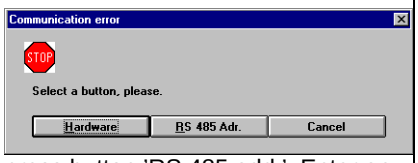
This section supports fault clearance with communication problems between PC and CLC. Other error messages from the SYNAX are described in the "Trouble Shooting Guide".

Fault	Cause	Remedy
SynTop signals at program start the message "SERCOS module does not respond"..."no communication possible"	Service cable not plugged in, not correctly plugged.	Check whether the connector of the service cable has been plugged into the correct interface.
	Service cable defective	With the help of Fig. 1-1 check to make sure the service cable has no breaks.
	Incorrect interface parametrization in SynTop	In the upcoming dialog box, press button "setup" and check whether the selected loop is configured for the correct connection.
	Incorrect interface parametrized to CLC	Switch power to CLC off and pull it out. Bridge jumper S2 or I6 (at CLC-P02). Switch on again and connect service cable to X27. Check parameter with SynTop: C-0-0011, C-0-0033, C-0-0104. If SynTop is communicating via X28 then set C-0-0104 correspondingly. Switch power to CLC off, remove jumper, switch CLC on and plug-in service cable to X28
SynTop signals at program start the message "COM-Port... in use or cannot be initialized correctly...."No communications possible."	The selected part is already in use by another software device. This device responds with correct protocol syntax.	End all applications except SynTop and press the button "Retry". - or - press button "Setup" in the dialog box and change the selected loop in the connection.
	The interface configured in SynTop does not exist.	In the dialog box, press the button "setup" and change the selected loop in the connection.
SynTop signals back the message "SERCOS module does not respond...."No Communication possible" after phase switching		CLC must be switched off and pulled out. Bridge jumper S2 or I6 (at CLC-P02). Power up again and connect service cable to X27. Check parameter with SynTop: C-0-0011, C-0-0033, C-0-0104. If SynTop is to communicate with X28, then set C-0-0104 accordingly, switch CLC off, remove jumper, switch CLC on and plug in service cable at X28
	Wrong RS485-address on the CLC or in the DDE server	See section "clearing special problems with RS485 communications"
At program start, SynTop signals message "hardware device is not a SERCOS module" ... "Communication telegrammes contain strange data"	The selected part B is already in use by another windows application.	End all applications except SynTop and then press the "Retry" button - or press button "setup" in dialog box and change the connection in the selected loop
SynTop suddenly signals during operation the message	Individual bits in transmission protocol have been kipped so that	Increase resistance to interference of transmission path, e.g., by using

"transmission on the line disturbed"..."faulty communication telegrams".	the checksums are incorrect. SynTop recognizes this and has requested the repeat telegrams which were also faulty.	a service cable that is both grounded and shielded
SynTop signals during operation the message "SERCOS module does not respond"...."No communication possible"	Service cable no longer correctly plugged.	Check whether the connector of the service cable is correctly plugged.
	During a parameter request, the drive was switched off or the fiber optic cable removed.	execute CLC reset and then press "Retry" button in dialog window.

Fig. 5-1: Fault clearance

5.2 Clearing Special Problems in RS485 Communications

Fault picture	Cause	Remedy
SynTop signals at program start the message "SERCOS module does not respond"..."Communications not possible" 	The last RS485 address addressed to does no exist.	Press the "Settings" button in the dialog box. In the following dialog: press button 'RS 485 add.'. Enter an RS 485 address of an existing CLC and press button 'OK'. 
	Two CLCs have the same RS485 address.	Make sure that no two CLCs in the RS485 link have the same address. For the setting, see section "Activating or and set up RS485 link".
SynTop signals during operation the message "SERCOS module does not respond"..."Communication is not possible". 	The address set for the CLC addressed (C-0-0142) has been changed.	Press the "Settings" button in the dialog box. In the following dialog:  press button 'RS 485 add.'. Enter an RS 485 address of an existing CLC and press button 'OK'.

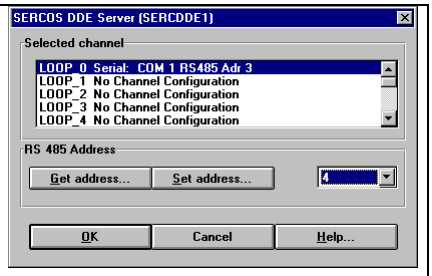
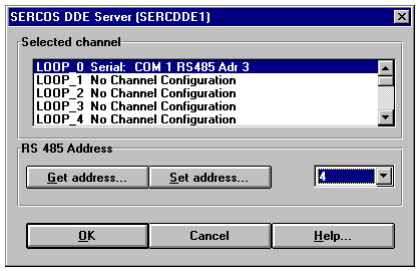
		
When executing the menu options|RS485 link|CLCs search/change SynTop signals a message "SERCOS module does not respond"..."Communication is not possible".	The last RS485 address addressed no longer exists.	Press the "Settings" button in the dialog box. In the following dialog: press button 'RS 485 add.'. Enter an RS 485 address of an existing CLC and press button 'OK'. 

Fig. 5-2: Troubleshooting with the RS 485 link

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SYNAX

Decentralized System for the Synchronization of Machine Axes

Appendix B: Interfaces

Indramat

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1 Siemens 3964R Interface (RS232 and RS422)

1.1 Introduction

This section describes the Siemens 3964R interface (RS232 and RS422) of the Indramat CLC-D control card.

This interface enables:

- the transmission of parameters,
- a switching from operating into parametrization mode and vice versa
- and the transmission of digital inputs and outputs.

The serial interface can be operated as a point-to-point connection or a bus via the serial ports of the CLC or via plug-in cards.

The serial user interface supports the user data transmitted in a telegram as well as the Motorola or Intel formats. These data formats are differentiated in terms of the serial order of the individual bytes of 2 and 4 byte data.

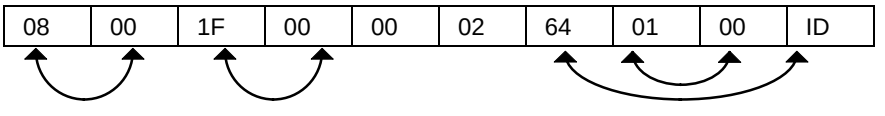
Example: The logical order of the data:

00	08	00	1F	00	02	1D	00	01	64
word		word		byte	byte	long (double word)			

The order of bytes sent in **Motorola format**

00	08	00	1F	00	02	1D	00	01	64

The order of bytes sent in **Intel format**



Note: To configure the serial interface, use parameter "host communication - control word" (C-0-0033).

1.2 Siemens S5 coupling 3964R

The specification "computer link with RK 512" forms the basis. The S5 interface is realized on the CLC in the form of a master/slave system. The S5 partner is always the master. It sends command telegrams. The CLC is always the slave. It only sends response telegrams.

There are two forms of command telegrams:

- **SEND telegrams** - data in this case is sent
- **FETCH telegrams**- data is prompted in this case.

The CLC then sends

- **response telegrams without data** - after a SEND telegram
- **response telegrams with data** - after a FETCH telegram.

If the number of user data exceeds 128 bytes, then following telegrams are sent with all type of telegrams.

Note: The Siemens S5 3964R coupling is activated in parameter "host communication - control word" (C-0-0033).

Order of transmission

The order of data transmission with SEND telegrams is as follows:

S5-unit	———	SEND telegram (telegram header + data)	——>	CLC
	<——	Response telegram without data	———	
	———	Following SEND telegram	——>	
	<——	Followng-response telegram without data	———	

Data transmission with FETCH telegrams is as follows:

S5 unit	———	FETCH telegram (telegram header + data header 1)	——>	CLC
	<——	Response telegram with data	———	
	———	Following FETCH telegram (only telegram header)	——>	
	<——	Following response telegram with data	———	

Note: It is necessary to wait for a response telegram after a command telegram. Only then can a new telegram be executed.

Telegram structure and content

A SEND telegram is made up of a telegram header and data. A FETCH telegram is only made up of a telegram and data header 1.

The telegram header is made up of ten bytres and, with a SEND telegram, contains information about the target of the data. There is information about the source of the data with FETCH telegrams.

1	2	3	4	5	6	7	8	9	10	11	....
0x00	0x00	command		DB no. target/source	DW-no.	high number	low	CPU no.KM		data	
telegram header										with SEND only	

1) The data header is only relevant to Indramat protcol expansion. It does not apply to data blocks.

The telegram header in following telegrams is reduced to the first four bytes:

1	2	3	4	5	....
0xff	0x00	command		data	
telegram header				with SEND only	

Byte definition

1 Telegram ID (0x00, or 0xff with following telegrams),

2 Telegram ID (always 0x00),

3 Command ==> 'A' = SEND, 'E' = FETCH,

4 Command type, i.e., type of data to be transmitted ==>
'D' = data blocks, all other types are not used

5,6 target address with SEND telegrams
source address with FETCH telegrams
byte 5 = data block number (DB no.)
byte 6 = data word number (DW no.) **is not evaluated or interpreted as 0**

7,8 number of user data to be sent in the unit [word], **is not evaluated with read access**

9 byte number of the coordination flag (with S5 only),

10 byte number of the coordination flag and CPU no. (only with S5).

Bytes 9 and 10 of the telegram header are not evaluated in the CLC.

The header of the response telegram is made up of four bytes and contains information about the course of the assignment.

Definition of the bytes:

1	2	3	4	5	....
0x00 (0xff)	0x00	0x00	F no.	data	
telegram header				only with FETCH	

Definition of the bytes:

1 Telegram ID (0x00, or 0xff with following telegrams),

2 Telegram ID (always 0x00),

3 command (always 0x00),

4 command number=> 0 = no error, otherwise error no. (See table)

Error number table:

Error no.	Cause
1	The telegram header does not agree with the specification.
2	A following telegram was received but not expected or a following telegram was expected but a normal telegram received.
3	The number of user data does not agree: the expected number (with following telegrams) or the signalled block length (with normal telegrams).

4	Prompts specified for the user data header or prompt unknown or not yet supported.
5	Prompt cannot presently be executed as the required data queue is full.
6	The CLC has signalled an error the A/C parameters.
7	The drive has signalled an error for the S/P parameters.
9	The data block specified is not available.
10	The length of the data block does not agree with the configuration.
14	Error during writing of I/O data (too many inputs).

Fig. 1-1: Error number table

Example: Data block no. 101 sent with a length of 128 bytes (0x40 words)

S5 unit:

1	2	3	4	5	6	7	8	9	10	11	...	138
0x00	0x00	'A'	'D'	0x65	0x00	0x00	0x40	0x00	0x00	...		
telegram header										data		

CLC:

1	2	3	4
0x00	0x00	0x00	0x00
telegram header			

Data block definitions

The following conditions apply to the data blocks (deviates from specification "computer coupling with RK 512"):

- The individual data blocks can only be accessed in their entirety. It is not possible to access individual elements of the data blocks (byte 6 in the command telegram is not evaluated; byte 7 not significant with read access. It is compared with block length during write access.).
- The length of the data blocks is limited to 128 bytes.

Pre-defined data blocks There are pre-defined data blocks on the CLC intended for specific tasks:

DB no 98 following telegram transmission broken off

This data block is used to tell the CLC that a data transmission, started with following telegrams, has been broken off by the S5 partner. The CLC then still completes an internal "clean up operation", does not pass the garbled data record on, and then sends a positive response telegram. The CLC is now ready to start a new transmission.

The data block can only be used in a SEND telegram and contains no data.

S5 unit:

1	2	3	4	5	6	7	7	9	10
0x00	0x00	'A'	'D'	0x62	0x00	0x00	0x00	0x00	0x00
telegram header									

CLC:

1	2	3	4
0x00	0x00	0x00	0x00
telegram header			

It can be sensibly implemented if the data line physically breaks down during data transmisison with following telegram, if the transmissin is not yet stable during the test phase, or if the S5 unit has crashed.

DB no. 99 I/O data

Inputs can be set via the serial interfaces and outputs read with this data block. User data has a data width of two bytes each and thus corresponds to the I/O data of a DEA. A maximum of 32 input or output words can be accessed.

Note: The use of data block 99 only makes sense in operating mode (phase 4).

First example: writing the CLC inputs

S5 unit:

1	2	3	4	5	6	7	8	9	10	11	12	13	14
0x00	0x00	'A'	'D'	0x63	0x00	0x00	0x02	0x00	0x00	0xA5	0x5A	0x12	0x34
telegram header										data			

CLC:

1	2	3	4
0x00	0x00	0x00	0x00
telegram header			

This example uses two input words via the serial interface for I/O handling. The two input values can be set as described above.

The following applies when writing inputs:

- If only the first word is accessed, then only one input value must be set (bytes 11 and 12).
- If the data record is made up of more than two input values, then the superfluous data is ignored.
- WORD access is used for I/O handlng via the serial interface. If only one bit is changed, then the 15 others must be transmitted with their old values.
- The CLC always positively acknowledges a write access in parametrization mode. Data is not, however, assumed.
- It is only possible to write to inputs, not read them.

Second example: reading CLC outputs

The outputs of the CLC look like this:

S5 unit:

1	2	3	4	5	6	7	7	9	10
0x00	0x00	'E'	'D'	0x63	0x00	0x00	0x00	0x00	0x00
telegram header									

CLC:

1	2	3	4	1	2	3	4
0x00	0x00	0x00	0x00	0xED	0xCB	0x5A	0xA5
telegram header				data			

Two output words are configured for I/O handling via the serial interface in this example.

The following applies when reading outputs:

- When reading CLC outputs, all configured outputs of the data record are sent. This means it is not possible to read only one single CLC output or one single output word.
- Read access during parametrization mode always results in an empty data record.
- Output can only be read not written into.

DB no. 100 switching modes

This data block supports mode switches between operating and parametrization modes. It is one word long. It is possible to read and write into this parameter. Data content indicates the current CLC mode, or speifies the mode to be switched into. Only two data contents are allowed:

2: parametrization mode

4: operating mode

Note: SEND telegrams are acknowledged with a positive response telegram before mode changeover is activated because the change from parametrization mode to operating mode can take up to 40 seconds depending on the number of axes. The success of a phase switching must, therefore, be checked by polling the current phase, e.g., read access with DB100. The CLC will only permit a mode change in operation mode if the master axis is standing and no drive enable signal is being applied to the drive. A mode switch will not be conducted if the phase specified is not permissible or a different change procedure is still active.

Example: Switching to operating mode:

S5 unit:

1	2	3	4	5	6	7	8	9	10	11	12
0x00	0x00	'A'	'D'	0x64	0x00	0x00	0x01	0x00	0x00	0x00	0x04
telegram header										data	

CLC:

1	2	3	4
0x00	0x00	0x00	0x00
telegram header			

Read current operating mode:

S5 unit:

1	2	3	4	5	6	7	7	9	10
0x00	0x00	'E'	'D'	0x64	0x00	0x00	0x00	0x00	0x00
telegram header									

CLC:

1	2	3	4	5	6
0x00	0x00	0x00	0x00	0x00	0x04
telegram header				data	

Configurable data blocks

On the CLC 16 data blocks can be freely configured for the 3964R interface. The configuration is effected via the 8 parameters "configuration list data block 101" (C-0-0058) to "configuration list data block 108" (C-0-0065). This corresponds to data block addresses 101 to 108. The 8 parameters "configuration list data block 109" (C-0-0078) to "configuration list data block 116" (C-0-0085) configure the data blocks with the addresses 109 to116.

C-0-0058 "configuration list data block 101"	———>	data block no. 101
C-0-0059 "configuration list data block 102"	———>	data block no. 102
C-0-0060 "configuration list data block 103"	———>	data block no. 103
		...
C-0-0065 "configuration list data block 108"	———>	data block no. 108
C-0-0078 "configuration list data block 109"	———>	data block no. 109
		...
C-0-0085 "configuration list data block 116"	———>	data block no. 116

These parameters are lists of variable length. Data width equals four bytes. Every element in the list designates a parameter in the associated data block and has the following struture (SYNAX format).

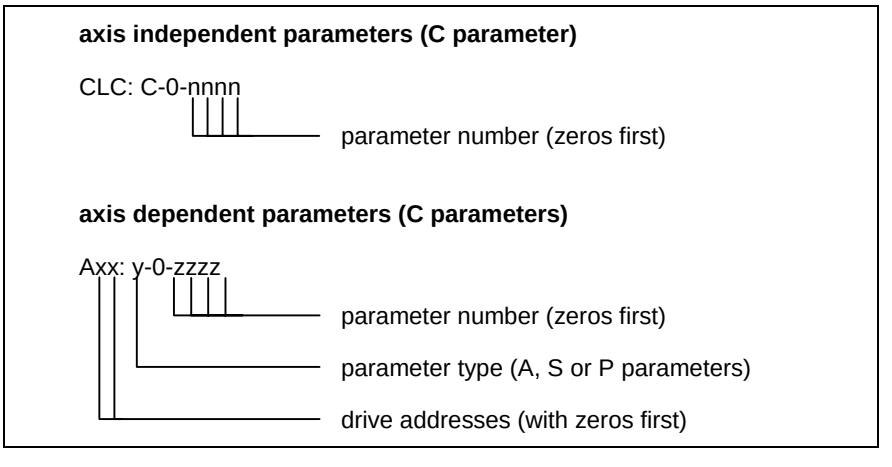

axis independent parameters (C parameter)
CLC: C-0-nnnn
parameter number (zeros first)
axis dependent parameters (C parameters)
Axx: y-0-zzzz
parameter number (zeros first)
parameter type (A, S or P parameters)
drive addresses (with zeros first)

Fig. 1-2: Parameter structure

Example:

Configuration list data block 1	Axis no.	Parameter ID	Data length	Parameter name	Weighting	Example of data contents
A01:A-0-0004	1	A-0-0004	4 bytes	position command offset	0.0001°	10°
A02:A-0-0004	2	A-0-0004	4 bytes	position command offset	0.0001°	0.1°
A03:A-0-0060	3	A-0-0060	2 bytes	fine adjustment	0.01%	3%
CLC:C-0-0006	-	C-0-0006	4 bytes	virtual master - speed command 1	0.0001 rpm	300 rpm

Fig. 1-3: Example of configurable data blocks

The resulting contents of data block 101:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	
00	01	86	a0	00	00	03	e8	01	2c	00	2d	c6	c0	hex
A-0-0004 axis 1				A-0-0004 axis 2				A-0-0060 axis 3		C-0-0006 master axis				

Example of transmissions

a) Write data: (see example: data block 101 = 0x65)

Master writes:

1	2	3	4	5	6	7	7	9	10
00	00	'A'	'D'	65	00	00	07	00	00
telegram header									

11	12	13	14	15	16	17	18	19	20	21	22	23	24	
00	01	86	a0	00	00	03	e8	01	2c	00	2d	c6	c0	hex
user data														

Slave acknowledges:

1	2	3	4
0x00	0x00	0x00	0x00
telegram header			

b) Read data: (see example above)

Master prompts data:

1	2	3	4	5	6	7	8	9	10
0x00	0x00	'E'	'D'	0x65	0x00	0x00	0x00	0x00	0x00
telegram header									

Slave sends data:

1	2	3	4
00	00	00	00
telegram header			

5	6	7	8	9	10	11	12	13	14	15	16	17	18	
00	01	86	a0	00	00	03	e8	01	2c	00	2d	c6	c0	hex
user data														

Notes on compiling a configuration list

The following must be noted when compiling a configuration list for transmitting data both efficiently and without error.

- The parameters are divided into four groups: the C, A, S and P parameters. The A and C parameters are on the CLC while the S and P parameters are on the drives.
  This means that accessing the S and P parameters will take longer because the CLC must first access these parameters via the SERCOS required data channel.
- Parameter groups can be mixed in any way desired within one data block. The number of S and P parameters should, with an eye towards the response time, be limited to what is necessary. The S and P parameters of an axes should also, with an eye towards the response time, not be arranged in sequence.

Example:

Disadvantageous		Advantageous	
S-0-0236	axis 1	S-0-0236	axis 1
S-0-0237	axis 1	S-0-0236	axis 2
S-0-0236	axis 2	S-0-0236	axis 3
S-0-0237	axis 2	S-0-0237	axis 1
S-0-0236	axis 3	S-0-0237	axis 2
S-0-0237	axis 3	S-0-0237	axis 3

Fig. 1-4: Example: Allocating parameter groups

- There are three classes of parameters within each group:
  - Parameters that can only be read, actual values, for example (**S**: write protected)
  - Parameters that an always be read but write not possible in parametrization mode, e.g., synchronization mode. (**B**: write protected in operating mode)
  - Parameters where read and write is always possible, e.g., setpoint values
    (**K**: Parameter not write protected)

The data blocks must be configured in such a way that no communications error can occur.

Data block access mode	Legal parameter classes within a data block	
Only read in all modes	S, B, K	see above
Read in all modes, write only in parametrization mode	B, K	see above
Read and write in all modes	K	see above

Fig. 1-5: Data block configurations

Handling S/P parameters when deactivating drives

In data blocks it is possible to configure A and C parameters of the CLC control as well as S and P parameters of the drive in any combination. To administer the data contents of a data block the data length of all configured parameters must be known CLC internally. Data lengths of S and P parameters are stored in the drives. If a drive is deactivated then it does not participate in communications via the SERCOS interface. The CLC cannot read out the length information.

Data blocks that access parameters on a deactivated drive must be transmittable without having to change the configuration. To support this, a list of "preferred parameters" is on the CLC. The list contains preselected S and P parameters and their lengths. The administration of a data block is thus basically also possible if not all addressed drives are active or present.

Given write accessing of parameters of a deactivated drive, the relevant data of the transmitted data block are discarded. Given read accessing, the CLC sends the value 0 for these parameters in the reaction telegram.

If a drive parameter is to be transmitted that is not in this preferred list, then it is possible to manually expand the list. Using parameters "data blocks - configurable S and P parameters, ID number" (C-0-0157) and "data blocks - configurable S and P parameters, data length" (C-0-0158) it is possible to expand up to 7 drive parameters.

The commissioning program SynTop offers a dialog for the settings with "CLC host communications". Use it to select additional S and P parameters.

List of the deposited CLC internal parameters see "data blocks - configurable S and P parameters, ID number" (C-0-0157) in SYNAX Parameter Description, DOK-SYNAX*-SY*-06VRS**-PA01-EN-P.

Hardware

Terminals X27 and X28 can be used for communications. The connector used must be set in parameter "host communication - control word" (C-0-0033).

RS232

Connector assignment

Ready-made cable IKS061 is available for connecting those participants which have nine pin, D subminiature connectors.

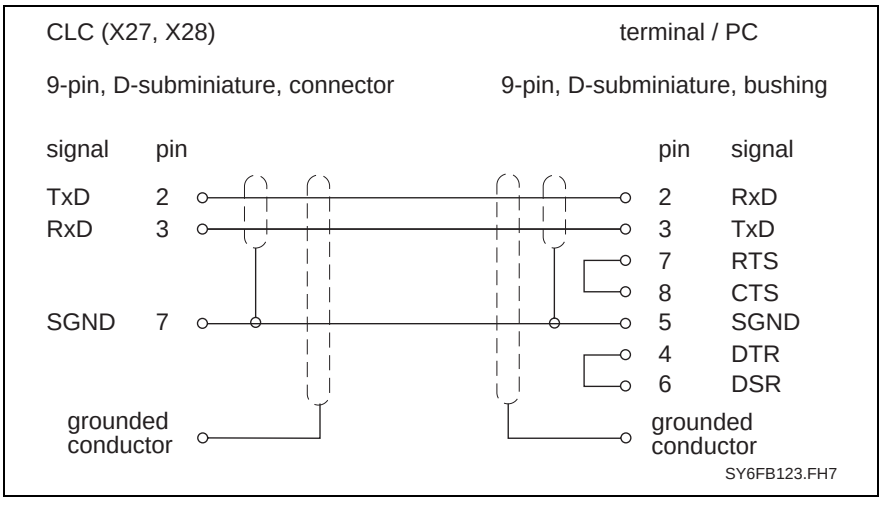


Fig. 1-6: Serial cable IKS 061

RS422

Connector assignment

To connect participants, there is either the ready-made cable INK 234 or the IKS 125 which is only ready-made at the CLC end.

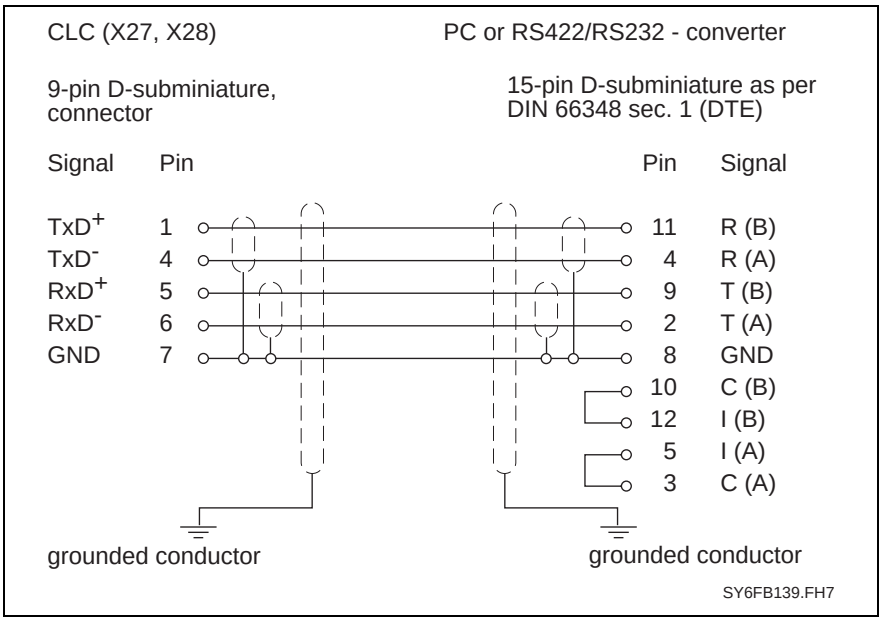


Fig. 1-7: Serial cable for RS422

Note: The baud rate of the 3964R is always 9600 baud (8 data bits, 1 stop bit and straight parity).

RS422 connection needs terminators at the start and at the end of the connection.

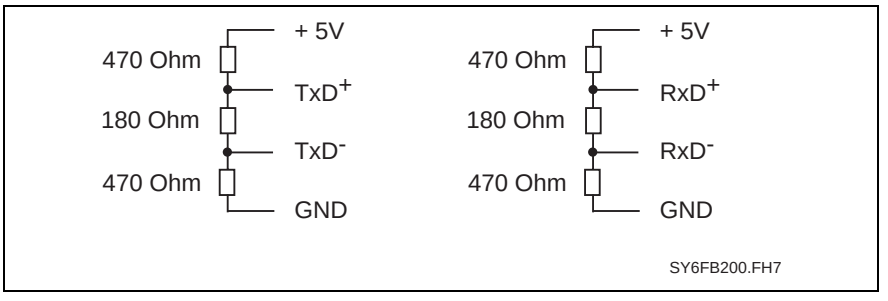


Fig. 1-8: Terminators of RS422 connection

1.3 Indramat protocol expansion

With the Siemens S5 interface and its inherent principle of the data block, it is only possible to transmit the operating data of parameters. Accessing other elements of a parameter is only then possible with an additional data access specification.

It is this specification that the Indramat protocol expansion supplies. It is put in front of the user data as a user data header in the first (with short transmissions, the only) telegram of a data transmission. As such it is subject to the data format specified for user data.

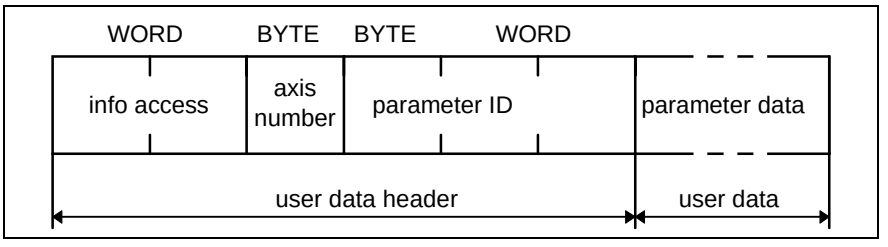
Without delimiting such standardized data blocks as DB99 or DB100, this protocol expansion can be used to select such functions as axis selection, I/O transmissions or mode changeovers.

The Indramat protocol expansion is made up of a data block with a six byte length and will be described in greater detail below for the support of

- parameter transmissions
- mode changeovers
- I/O transmissions
- axis selection for multiple transmissions.

The parameter transmission

The following user data header is used in this case



Access info (parameter transmission)

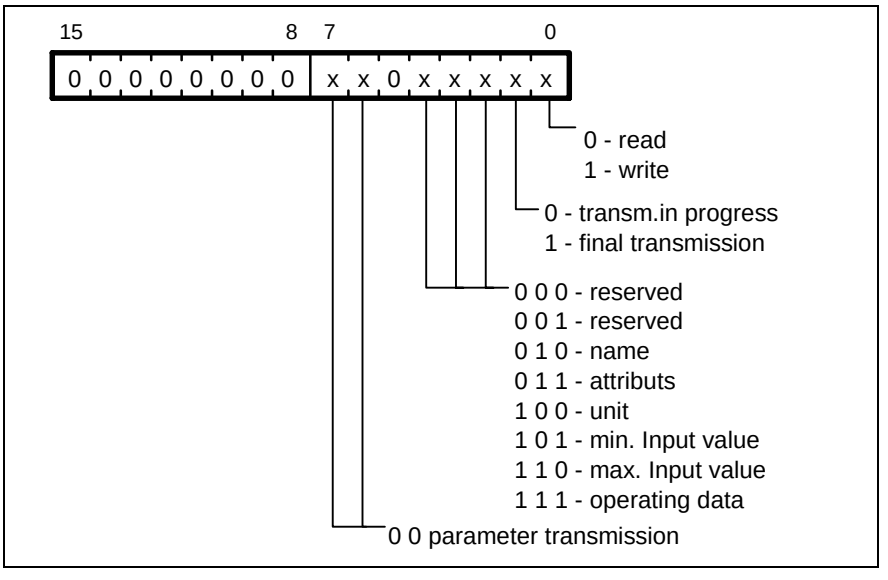

15
8
7
0
0 0 0 0 0 0 0 0
x x 0 x x x x x
0 - read
1 - write
0 - transm.in progress
1 - final transmission
0 0 0 - reserved
0 0 1 - reserved
0 1 0 - name
0 1 1 - attributs
1 0 0 - unit
1 0 1 - min. Input value
1 1 0 - max. Input value
1 1 1 - operating data
0 0 parameter transmission

Fig. 1-9: Access info (parameter transmission)

Axis number

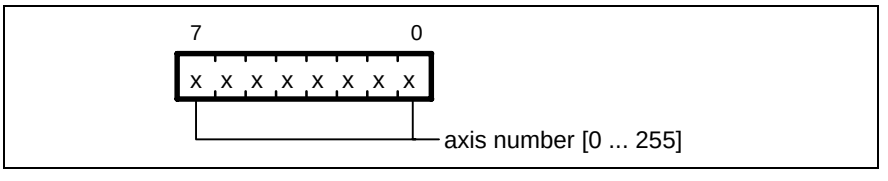


Fig. 1-10: Axis number

Parameter ID

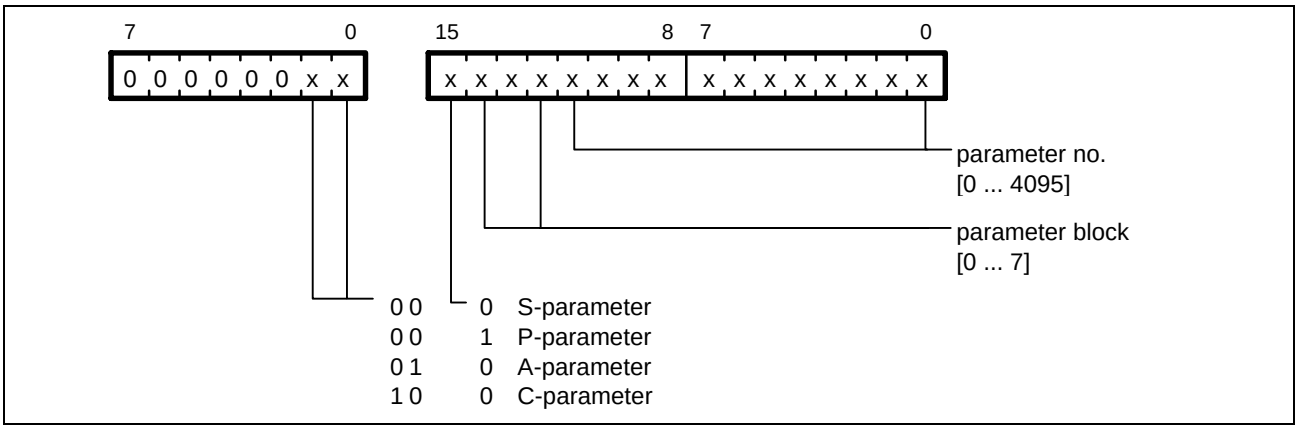

7 0
0 0 0 0 0 0 x x
15 8 7 0
x x x x x x x x x x x x x x x x
parameter no.
[0 ... 4095]
parameter block
[0 ... 7]
0 0 0 S-parameter
0 0 1 P-parameter
0 1 0 A-parameter
1 0 0 C-parameter

Fig. 1-11: Parameter ID (parameter transmission)

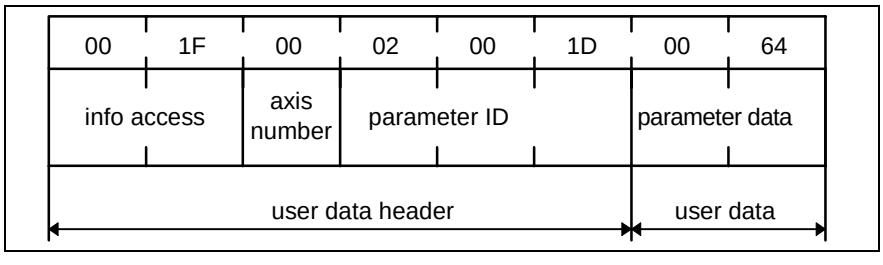
Parameter data

The length of the parameter data is outlined in the "SYNAX Parameter Description".

Writing a parameter

When writing, the superordinate system transmits parameter data to the CLC.

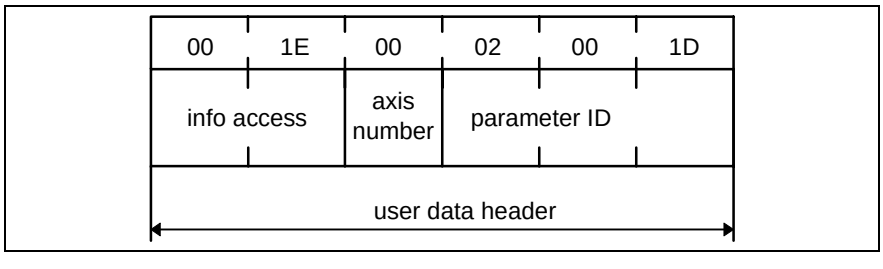
Example: Transmit parameter "jogging time constant" (C-0-0029) = 100, parameter length: two bytes.



Reading a parameter

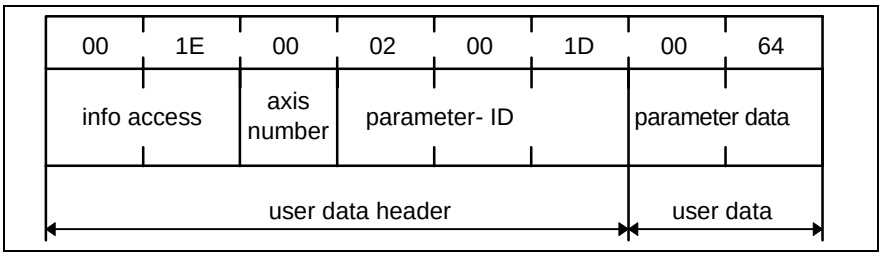
When reading, the superordinate system sends a transmission prompt to the CLC.

Example: Read parameter "jogging time constant" (C-0-0029)



The CLC now sends the parameter contents to the superordinate system.

Example: "Jogging time constant" (C-0-0029) = 100, parameter length: two bytes.



If the telegram is longer than 1024 bytes, then the byte info access must contain the message "transmission in progress" (bit 1 = 0).

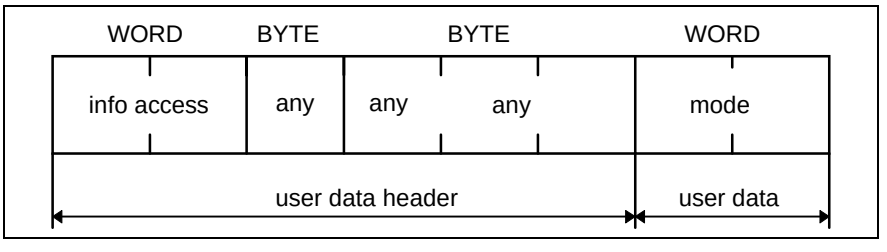
To send the remaining segments of the data it is necessary to repeat all processes until transmission has been completed. The completion is then signalled by the CLC with "final transmission" (bit 1 = 1).

Switch mode

With the help of switch mode, it is possible to switch the CLC from operating into parametrization mode and vice versa. Otherwise, the current mode can be queried.

The switch mode protocol is largely identical to parameter transmission.

Switch mode protocol (user data)



Info access (switch mode)

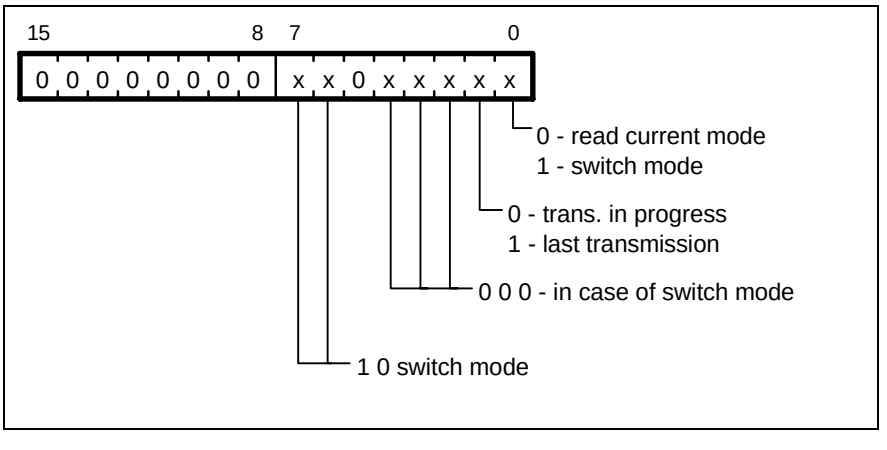

15
8
7
0
0 0 0 0 0 0 0 0
x x 0 x x x x x
0 - read current mode
1 - switch mode
0 - trans. in progress
1 - last transmission
0 0 0 - in case of switch mode
1 0 switch mode

Fig. 1-12: Info access (switch mode)

Mode

= 2: parametrization mode

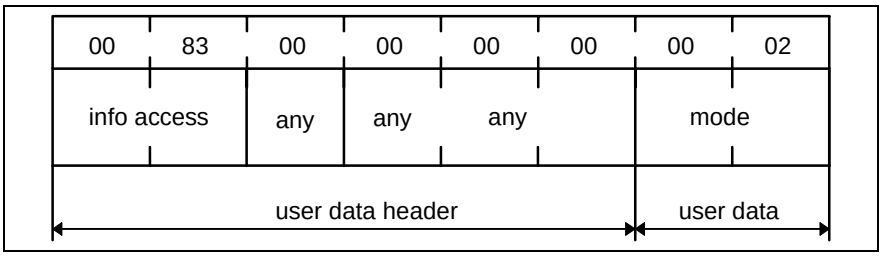
= 4: operating mode

Switch mode order

The superordinate system sends a switch sequence to the CLC.

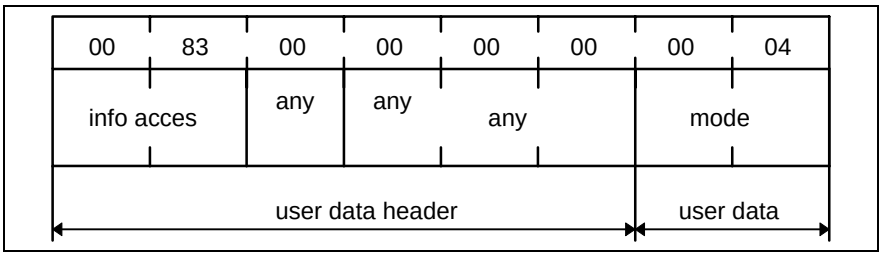
Switching into parametrization mode

To switch into parametrization mode, the superordinate system sends the following sequence to the CLC.



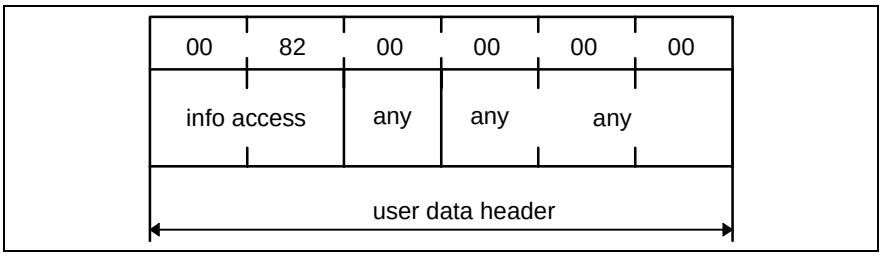
Switching to operating mode

To switch into operating mode, the superordinate system sends the following sequence to the CLC:

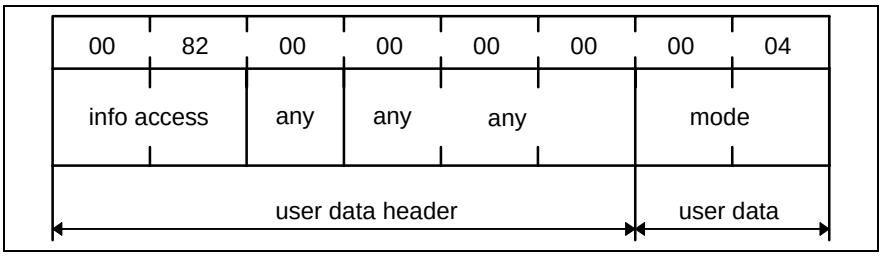


Reading current operating mode:

To read the current operating mode, the superordinate system sends the following sequence to the CLC:



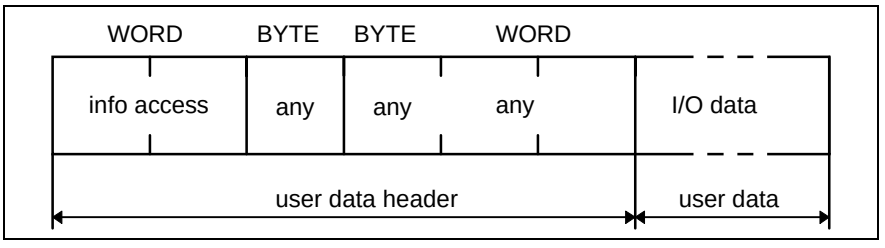
If the CLC is in operating mode, then the response is as follows:



I/O transmission

The assignment possibilities of the digital I/Os of the CLC are described in section 4 in detail.

The following user data header is used for the I/O transmissions:



Telegram length is specified in bytes.

Info access (I/O transmission)

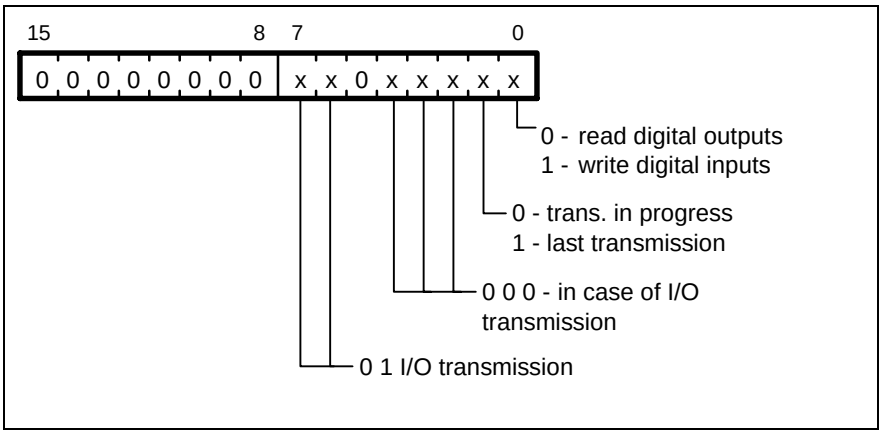

15
8
7
0
0 0 0 0 0 0 0 0
x x 0 x x x x x
0 - read digital outputs
1 - write digital inputs
0 - trans. in progress
1 - last transmission
0 0 0 - in case of I/O transmission
0 1 I/O transmission

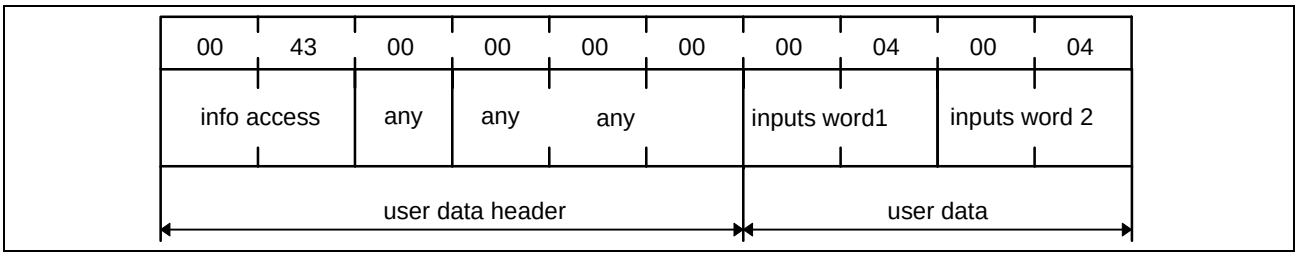
Fig. 1-13: Info access (I/O transmission)

The I/Os are organized in words, i.e., 2, 4 and 6 bytes are always transmitted.

Writing the digital inputs of the CLC

When writing, the superordinate system sends the digital inputs to the inputs of the CLC.

Example: Transmission of two word inputs 0A0F and B0E0

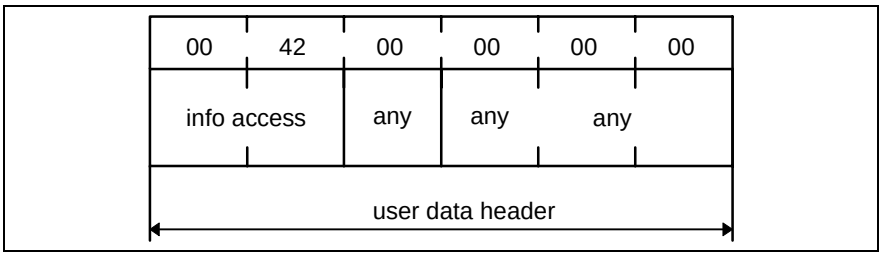


Reading the digital outputs of the CLC

When reading, the superordinate system sends a transmission request to the CLC.

Example: Reading the digital outputs.

Note: This sequence is always the same.

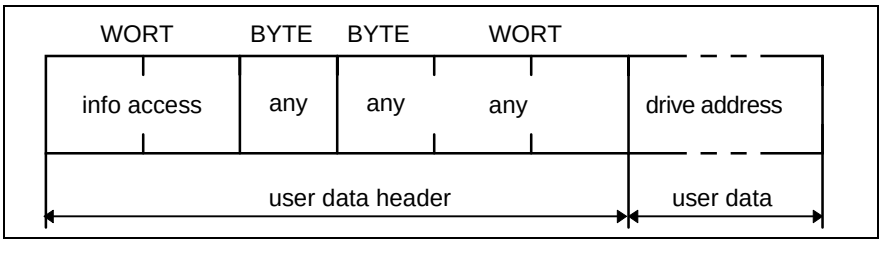


The CLC now sends its digital outputs to the superordinate system.

Select axis for multiple transmission

Considering the relatively slow transmission speeds of serial interfaces, it is advantageous to transmit a data record to several drives, only once to the CLC. Once the CLC has the inforation as to which drive it must transmit the data to, then a multiple transmission can be internally run.

The following is the user data header for axis selection:



Info access (select axis)

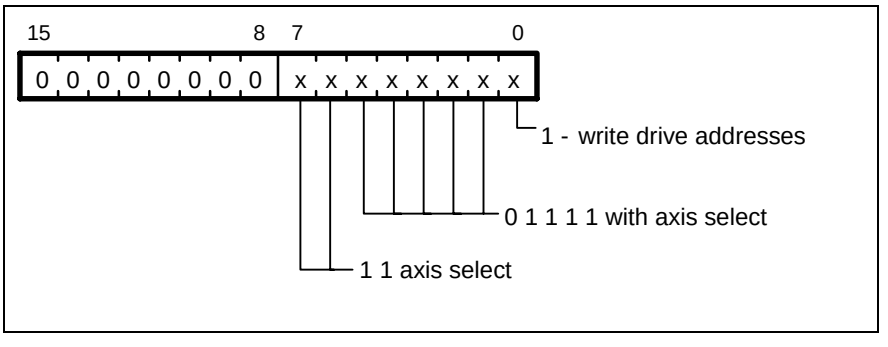


Fig. 1-14: Info access (axis select)

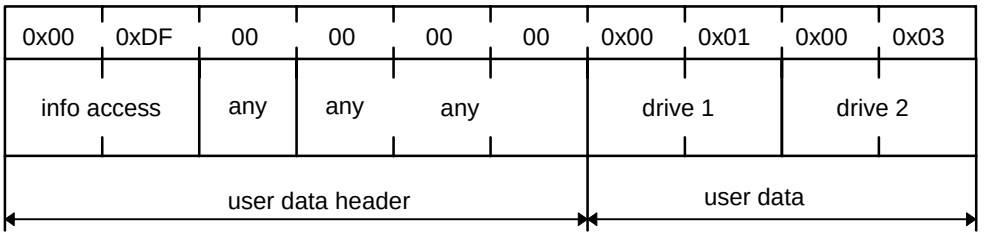
Axis select order

The drive addresses are organized in words. This means that 2, 4 and 6 bytes are always transmitted.

Writing the drive addresses

When writing, the superordinate system sends drive addresses to the CLC.

Example: Transmit drive addresses 1 and 3

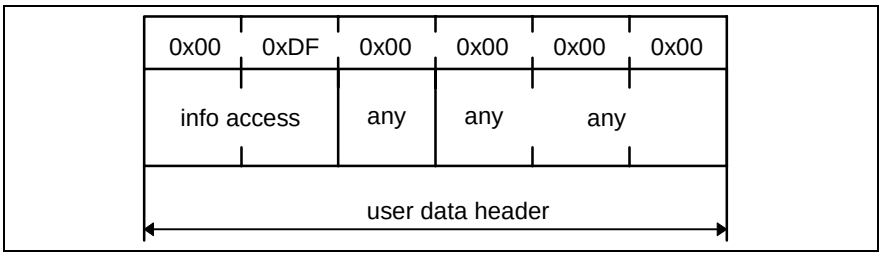


Once an axis has been selected, it is relevant for all write accesses of A, S or P parameters. This applies until the select list is changed or cleared.

The axis selected is cleared by means of any empty drive address list (no user data).

Example: Clearing the axis select list.

Note: This sequence is always the same.



Note: A reading of axis select is not intended. A read access will clear the list.

1.4 3964R with Indramat protocol expansion

The protocol expansion resulting from the 3964R makes it possible to access every C, A, S or P parameter without preliminary definition of data blocks. In addition to the operating data, it is also possible to simultaneously read their unit, name, attribute, minimum and maximum values.

Note: 3964R with Indramat protocol expansion is supported by standard protocol drivers for write access only (SEND telegrams.
A protocol driver for read access (FETCH telegram) is needed that can also issue the Indramat protocol expansion over and above the telegram header with FETCH telegrams.

In conjunction with the 3964R, bit 1 of the information access of the Indramat protocol expansion (in progress/last transmission - see Indramat protocol expansion, 1.3 ff) is of no significance. It is automatically handled by the CLC via the telegram length.

Standard transmission with data block D0

There is no restriction as to the length of parameter tables.

The data field is divided into user data header and user data with protocol expansion. Both the user data header and the user data correspond to the specification outlined in section Order of transmission, page 1-2. The user data are only in SEND telegrams.

1	2	3	4	5	6	7	8	9	10
0x00 (0xff)	0x00	command		high. target/source	low	high number	low	CPU-no./KM 0	0
telegram header									

11	12	13	14	15	16	17	...
info access		axis no.	parameter ID			parameter data	
user data header						user data	

Byte definition:

1 telegram ID (0x00, or 0xff with following telegrams),

2 telegram ID (always 0x00),

3 command ==> ’A’ = SEND, ’E’ = FETCH,

4 command type, i.e., type of data to be transmitted ==>
’D’ = data block, all other types not used,

5,6 target address with SEND telegrams (0,0),
source address with FETCH telegrrams (0, 01)

7,8 number of user data to be transmitted including user data header in the unit [word].

9 byte number of the coordination flage (only in S5),

10 bit number of the coordination flag and CPU no. (Only in S5).

11...16 see section Indramat protocol expansion, 1.3 ff

Bytes 6, 9 and 10 of the telegram header have no meaning in the CLC.

The response telegram is structured as follows. The response telegram is made up of only one telegram header in SEND telegrams. In FETCH telegrams, only the user data follow. The user data header is not repeated.

1	2	3	4	5	...
0x00 (0xff)	0x00	comm and	error no.	parameter data	
telegram header				user data	

Byte definition:
1 telegram ID (0x00, or 0xff with following telegrams),
2 telegram ID (immer 0x00),
3 command (immer 0x00),
4 error number ==> 0 = no error, otherwise error.

Examples for a transmission

a) Writing data: (axis 3, parameter S-0-0236 := 13)

Master writes:

1	2	3	4	5	6	7	8	9	10
0x00	0x00	command 'A'	'D'	target/source 0x00	0x00	number 0x0005		CPU-no./KM 0x00	0x00
telegram header									

11	12	13	14	15	16	17	18	19	20
Info access 0x001F		axis-no. 0x03	parameter ID 0x0000EC			parameter data 0x0000000D			
user data header						user data			

Slave acknowledges:

1	2	3	4
0x00	0x00	0x00	error no. 0x00
telegram header			

b) Read data: (axis 2, parameter S-0-0237 = 7)

Master prompts data:

1	2	3	4	5	6	7	8	9	10
0x00	0x00	command 'E'	'D'	target/source 0x00	0x00	number 0x00	0x00	CPU-no./KM 0x00	0x00
telegram header									

11	12	13	14	15	16
info access 0x00	0x00	axis no. 0x02	parameter ID 0x0000ED		
user data header					

Slave transmits data:

1	2	3	4	5	6	7	8
0x00	0x00	0x00	error no. 0x00	parameter data 0x00000007			
telegram header				user data			

c) Axis select for multiple transmission: (drive addresses 1 and 4)

Master writes:

1	2	3	4	5	6	7	8	9	10
		command		target/source		number		CPU no./KM	
0x00	0x00	'A'	'D'	0x00	0x00	0x0005		0x00	0x00
telegram header									

11	12	13	14	15	16	17	18	19	20
info access		axis-no.	parameter ID			drive address		drive address	
0x00DF		0x00	0x000000			0x0001		0x0001	
telegram header									

Slave acknowledges:

1	2	3	4
			error no.
0x00	0x00	0x00	0x00
telegram header			

The following applies when selecting an axis for multiple transmission:

- The list with the selected drives (drive list) is empty after the CLC is run up. Data is transmitted, as usual, in individual transmissions.
- A prepared drive list remains relevant for write access with the Indramat user level until it is changed or cleared.
- The drive list is cleared by a select command without drive address.
- The choise of axis has no effect on data transmission with data blocks, on C parameters or any type of read accessing.
- Transmission to the drive is done in the sequence set by the select list.
- Multiple transmissions of S and P parameters in parametrization mode requires much more time than when in operating mode. This also applies to A parameters when in operating mode. The transmission of S and P parameters in this case runs paralle.
- A sequential data transmission is interrupted in the event of an error. This is not true of parallel transmission because the prompt is first sent to all drives and only then are the replies evaluated.

Note: When loading a long list (more than 1984 data words), the CLC sends, prior to the internal SERCOS transmission, a positive reaction telegram on the final partial telegram of the list. The results of the SERCOS transmission can be checked by reading parameter "Serial interface error number" (C-0-0057).
Up to the end of the SERCOS transmission or the making available of the results on C-0-0057, all command telegrams from the CLC will be responded to with a BUSY signal. In other words, C-0-0057 is polled until the CLC again sends a positive reaction telegram.

Using the Siemens S 5 to send long lists

Lists with a maximum of 2043 data words can be sent with the standard S5 control. This restriction does not apply to other master units.

Data blocks DB1 -DB5 are available to support the transmission of long parameter lits, even with a standard Siemens S5 control, e.g., cam tables P-0-0072. Like DB0, these also cannot be configured and only support Indramat protocol expansion.

In contrast to DB0, a normal telegram is expected after 30 following telegrams. Several aspects of this normal telegram must correlate with the first normal telegram.The following applies to DB1 to DB5.

- They cannot be configured.
- They only support the Indramat user level (in long lists).
- They are compatible with the Siemens S5.
- They are limited. This means that after a sequence of one normal telegram and 30 following telegrams, precisely one normal telegram, and maximum of 30 following telegrams, is now expeted duntil all the data are transmitted.
- In the following normal telegrams, the Dbs are counted down to DB1.
- The data length of the remaining data record must be contained in the telegram header of the last normal telegram (only values <= block length are allowed). The maximum block length of 1984 data words is always contained in the previous telegrams.
- Command (0x41) and command type (0x44) must always agree in the following normal telegrams. The DB number being monitored must also be decremented.
- The following normal telegrams are treated in the CLC as if they were following telegrams. This is why the data length in the following normal telegtrams is not monitored.

The length of the data record determines which data block starts data transmission. The number nn of the data block results from the equation

$$nn = \frac{\text{number of data words} + 1983}{1984}$$

Fig. 1-15: Number of the data block

Example: With 2053 data words (cam),

$$nn = \frac{2053 + 1983}{1984} = \frac{4036}{1984} = 2$$

Fig. 1-16: Example: Number of the data block

as the relevant number of the data block. Loading a cam (P-0-0072) out of the Siemens S5 into CLC thus looks liks this:

- First, 1984 data words are sent to data block DB2 of the CLC from the expanded DB of the S5,
- now follows the remaining 69 data words to the DB1 of the CLC from any DB of the S5.

With data blocks DB1 - DB5, a maximum of (1984*5=) 9920 data words (equals 19.375 Kbytes data) can be transmitted to the CLC.

Example for writing to a cam (P-0-0072), drive 1) with Siemens S5.

The Siemens-S5 sends the SEND telegram for the DB2:

1	2	3	4	5	6	7	8	9	10
0x00	0x00	0x41	0x44	0x02	0x00	0x07	0xc0	0x00	0x00
telegram header									

11	12	13	14	15	16	17	18	19	20
0x00	0x1f	0x01	0x00	0x80	0x48	0x10	0x00	0x10	0x00
user data header						list length (actual, maximum)			

21	22	23	24	25	26	27	28	29	30
0x00	0x00	0x00	0x01	0x00	0x00	0x00	0x02	0x00	0x00
user data (always 4 bytes per support point of the cam)									

31	32	33	34	..	..	135	136	137	138
0x00	0x03	0x00	0x00	..	..	0x00	0x1d	0x00	0x00
user data (a total of the first 118 bytes of the cam)									

The CLC sends response telegram:

1	2	3	4
0x00	0x00	0x00	0x00
telegram header			

The Siemens S5 sends the first following SEND telegram:

1	2	3	4
0xff	0x00	0x41	0x44
telegram header			

5	6	7	8	9	10	11	12	13	14
0x00	0x1e	0x00	0x00	0x00	0x1f	0x00	0x00	0x00	0x20
user data (always 4 bytes per support point of the cam)									

15	16	17	18	..	..	129	130	131	132
0x00	0x00	0x00	0x21	..	..	0x00	0x3d	0x00	0x00
user data (a total of the first 128 bytes of the cam)									

The CLC sends the first following response telegram:

1	2	3	4
0xff	0x00	0x00	0x00
telegram header			

The Siemens S5 sends the second following SEND telegram:

1	2	3	4
0xff	0x00	0x41	0x44
telegram header			

5	6	7	8	9	10	11	12	13	14
0x00	0x3e	0x00	0x00	0x00	0x3f	0x00	0x00	0x00	0x40
user data (always 4 bytes per support point of the cam)									

15	16	17	18	..	..	129	130	131	132
0x00	0x00	0x00	0x41	..	..	0x00	0x5d	0x00	0x00
user data (a total of the first 128 bytes of the cam)									

The CLC sends the second following response telegram:

1	2	3	4
0xff	0x00	0x00	0x00
telegram header			

The Siemens S5 ends the 30th following SEND telegram:

1	2	3	4
0xff	0x00	0x41	0x44
telegram header			

5	6	7	8	9	10	11	12	13	14
0x03	0xbe	0x00	0x00	0x03	0xbf	0x00	0x00	0x03	0xc0
user data (always 4 bytes per support point of the cam)									

15	16	17	18	..	..	129	130	131	132
0x00	0x00	0x03	0xc1	..	..	0x03	0xdd	0x00	0x00
user data (a total of the first 128 bytes of the cam)									

The CLC sends the 30th following response telegram:

1	2	3	4
0xff	0x00	0x00	0x00
telegram header			

The Siemens S5 sends the SEND telegram for DB1:

1	2	3	4	5	6	7	8	9	10
0x00	0x00	0x41	0x44	0x01	0x00	0x00	0x45	0x00	0x00
telegram header									
11	12	13	14	15	16	17	18	19	20
0x03	0xde	0x00	0x00	0x03	0xdf	0x00	0x00	0x03	0xe0
user data (always 4 bytes per support point of the cam)									

21	22	23	24	..	..	135	136	137	138
0x00	0x00	0x03	0xe1	..	..	0x03	0xfd	0x00	0x00
user data (a total of the first 128 bytes of the cam)									

The CLC sends the reaction telegtram:

1	2	3	4
0xff	0x00	0x00	0x00
telegram header			

The Siemens S5 sends the first and simultaneously the last following SEND telegram:

1	2	3	4
0xff	0x00	0x41	0x44
telegram header			

The CLC sends the first and simultaneously the last following response telegram after transmission to the drive(s).

5	6	7	8	9	10	11	12	13	14
0x03	0xfe	0x00	0x00	0x03	0xff	0x00	0x00	0x04	0x00
user data (the final ten bytes of the cam)									

1	2	3	4
0xff	0x00	0x00	0x00
telegram header			

Note: When loading a long list (more than 1984 data words), the CLC sends, prior to the internal SERCOS transmission, a positive reaction telegram on the final partial telegram of the list. The results of the SERCOS transmission can be checked by reading parameter "Serial interface error number " (C-0-0057).
Up to the end of the SERCOS transmission or the making available of the results on C-0-0057, all command telegrams from the CLC will be responded to with a BUSY signal. In other words, C-0-0057 is polled until the CLC again sends a positive reaction telegram.

If some of DB1 or DB5 are already assigned, then the previously described transmission of a cam can also be executed with the additional data blocks DB6 through DB10. The block numbers correlate as follows:

DB5 <————> DB10
DB4 <————> DB9
DB3 <————> DB8
DB2 <————> DB7
DB1 <————> DB6

DB2 must be released to DB7 and DB7 and DB1 by DB6 in the telegrams in order to transmit a cam.

2 PC Interface (CLC-P: ISA-PC/104 bus)

2.1 Introduction

This section describes the user interface between a PC and the Indramat control cards CLC-P01: ISA bus or CLC-P02: PC/104 bus.

This card, in conjunction with the Indramat functions

- electronic gearbox,
- electronic cam and
- electronic pattern control

makes it possible to develop software for a specific application.

Also described are different modes of data exchange implementing the PC bus interface.

2.2 Installation

Hardware prerequisites:

computer	IBM-AT or compatible
operating system	any
main memory	any
memory expansion	any
hard drive	any
disk drive	any
slots	8 bit slot (ISA bus) 16 bit slot (CLC-P02: PC/104 bus)
graphics card	any

Fig. 2-1: Hardware prerequisites

The CLC-P uses one of the hardware interrupts 2, 3 or 5 (adjusted in terms of the jumper). The CLC-P02 uses one of the hardware interrupts 10, 11, 12 or 15 (can be set with the DIP switch). Prior to installation, however, it must be made certain that the interrupt used is not being used for any other application.

2.3 A description of the Dual Port RAM interface

General information

A 2K word dual port (2K x 16 bit) RAM is used for communications between the CLC-P and the PC. Communication via the 4Kword dual port RAM (4K x 16 bit) uses the CLC-P02.

Various buffers are available for data exchange. Communication is controlled via interrupts and the contents of the associated DPRAM register.

The following relationship exists between the PC and the CLC-P.

- When parameters are transmitted, the PC requests transmission and the CLC-P acknowledges after executing the transmission.
- For transmission of pattern data, the CLC-P requests transmission, the PC transmits the pattern data and the CLC-P acknowledges after executing the transmission.
- For the PC to be able to recognize a CLC-P, the CLC writes an identification reset into the DPRAM after switch on.

The memory locations of the DPRAM are listed in the "Appendix", page 2-23.

Base address

Note: In the following sections, addresses are always specified relative to this base address.

The various possible base addresses are shown in the "Appendix", page 2-23.

CLC-P01 (ISA bus)

The base address of the DPRAM can be set by means of four plug-in jumpers.

Sixteen different base addresses can be set in 16K steps over a range of C000:0000h to F000:C000h. The various possible settings are shown in the appendix.

Note: The base address of the dual port RAM can be set with four jumpers, viz., S8, S9, S10 and S 11.

CLC-P02 (PC/104 bus)

The DIP switch S1 can be used to set the base address of the DPRAM.

Sixteen different base addresses can be set in the range from D000:0000h to E000:E000h in 8K increments. The various setting options are outlined in the Appendix.

Note: The base address of the Dual Port RAM can be set with DIP switches S1.1 to S1.4.

Memory locations

Memory locations are shown in the appendix. These are set in register DPRAM_CONF. (See "Initializing the DPRAM interface", page 2-5)

Interrupts

Note: The interrupt registers are on the CLC-P01 (ISA bus) and CLC-P02 (PC/104 bus) at different DPRAM addresses.
CLC-P01 (ISA bus): CLC_IRQ $FFE PC_IRQ $FFC

CLC-P02 (PC/104 bus): CLC_IRQ $1FFC PC_IRQ $1FFE

CLC-P Interrupts (CLC_IRQ)

An interrupt is triggered on the CLC-P by the PC when writing to the interrupt register CLC_IRQ.

This interrupt (the hardware signal) is reset when the register is read by the CLC-P .

The CLC-P then resets the register.

PC interrupts (PC_IRQ)

An interrupt is triggered on the CLC-P when writing to the interrupt register PC_IRQ.

This interrupt is reset when the register is cleared by the PC. If the PC user polls the register because the PC interrupt is not to be used, then it must be cleared again.

Overview of the interrupts:

A bit is assigned in the corresponding register to each type of interrupt. If the PC wishes to trigger a TRMT_REQ on the CLC-P, then the PC must set bit number 1 in register CLC-IRQ.

To do this, the hexadecimal value $0002 and the previous contents of the register are combined via an OR operation and written to the register. This hexadecimal value is specified below.

The following types of interrupts are defined:

CLC-P interrupts ($FFE):		**PC interrupts ($FFC):**	
INIT_REQ	$0001	INIT_RESP	$0001
TRMT_REQ	$0002	TRMT_RESP	$0002
PATTERN_RDY	$0004	PATTERN_ACK	$0004
MODE_REQ	$0008	MODE_RESP	$
		ERROR_MSG	$0010
		BUSY_MSG	$0040
		PATTERN_REQ_A	$0080
		PATTERN_REQ_B	$0100
		REBOOT_MSG	$4000
		REQ_INVALID_MSG	$8000

Fig. 2-2: Interrupt types

INIT interrupt [$0001]

Communications between the CLC-P and the PC is started with the intialization interrupt. The CLC-P runs a wait loop as long as no valid initialization interrupt INIT_REQ is detected.

TRMT interrupt [$0002]

Transmit interrupts (TRMT) are used to transmit parameters. Each PC request is exected as a TRMT_REQ. The reply is passed on by the CLC-P with a TRMT_RESP.

PATTERN interrupt [$0004]

Pattern interrupts are used to transmit pattern data.

The CLC-P requests a pattern data transmission with PATTERN_REQ_A or PATTERN REQ_B. The PC transfers the pattern data to the CLC-P with PATTERN_RDY. The CLC-P acknowledges the processing of the pattern data with PATTERN_ACK.

MODE interrupt [$0008]

This interrupt is used for changing over between parametrization and operating modes.

The PC requests a mode change with MODE_REQ. The CLC-P acknowledgs the current mode with MODE_RESP.

Other CLC interrupts are now allowed and are acknowledged with REQ_INVALID_MSG.

ERROR interrupt [$0010]

An error interrupt is triggered, for example, in the event of faulty communications with the drive.

An error number (register ERROR_REG, address $FEA) and fault information (register ERR_INFO, address $FE8) are passed to the DPRAM with an interrupt.

Mode changeover can also follow the error, i.e., the drives are then no longer ready. The current mode can then be read from the CLC_MODE register (address $FFA).

BUSY Interrupt [$0040]

The busy interrupt is triggered by the CLC-P is data transmission is presently not possible.

Causes might be:

- Transmission of data blocks or list parameters, e.g., cams, via a serial interface.
- Sequence of timeout span (C-0-0124) for data transmissions.

PATTERN_REQ_A [$0080]

The CLC-P uses this interrupt to request new control data for the A range.

PATTERN_REQ_B [$0100]

The CLC-P uses this interrupt to request new control data for the B range.

REBOOT_MSG [$4000]

This interrupt triggers the CLC-P after a warm start.

The CLC-P automatically switches into phase 0 after

- and emergency SERCOS response,
- a grave operating systems error.

If the CLC-P is runup out of this state, then it will automatically conduct a warmstart. The host is informed of this with the REBOOT_MSG. After a REBOOT_MSG the host must re-initialize the CLC-P with INIT_REQ.

REG_INVALID_MSG [$8000]

In response to an unallowed CLC-P interrupt, the CLC-P responds to the host with REQ_INVALID_MSG.

Note: The interrupts PATTERN_REQ_A, PATTERN_REQ_B and REBOOT_MSG are tripped by the CLC-P itself; all other PC interrupts only upon demand.

Initializing the DPRAM interface

Communications between the PC and the CLC-P is built up with the initialization interrupt. The PC triggers this interrupt by writing INIT_IRQ into register CLC_IRQ.

Before the interrupt can be transmitted to the CLC-P, the DPRAM_CONF register must be written into. The contents of the register determine whether the data buffer in the DPRAM is of standard size, or whether it will be configured by the user.

Note: The buffer lengths for non-cyclial data transmission (parameter transmit and receiver buffer), cyclical data transmission (real time data buffer, actual and command values) and pattern data transmission can be configured.The buffers for binary inputs and outputs cannot be configured. For this purpose, 128 words are available.

Standard buffer

The value "0" is written into the DPRAM_CONF register. This fixes buffer length as follows:

parameter transmit buffer	- 512 words
parameter receive buffer	- 512 words
real time data buffer for actual values	- 256 words
real time data buffer for command value	- 256 words
pattern data buffer	- 128 words

Before the CLC-P acknowledges the initialization interrupt, the standard sizes are stored in the DPRAM:

PAT_BUF_SIZE = 128

CYC_BUF_SIZE = 256

PAT_BUF_SIZE = 512

Configured buffer

The value "1" is written into the DPRAM_CONF register, if the user configures the DPRAM. The buffer length must be written into the following registers before the initialization interrupt is triggered:

PAT_BUF_SIZE = size of the parameter send and receive buffers

CYC_BUF_SIZE = size of the real time data buffer

PAT_BUF_SIZE = size of the pattern data buffer

Buffer size must be indicated in words.

The DPRAM is configured by the CLC one the initialization interrupt is triggered. INIT_IRQ is subsequently acknowledged.

2.4 Parameter transmission

Parameters are all data with which the CLC-P or a drive are parametrized. Parameters are transmitted asynchronously, i.e., transmission is not synchronized with an internal clock.

Protocol parameter transmission

Parameter transmission can be triggered by the PC with write and read commands.

The same protocol is specified in the transmit as well as the receive buffer:

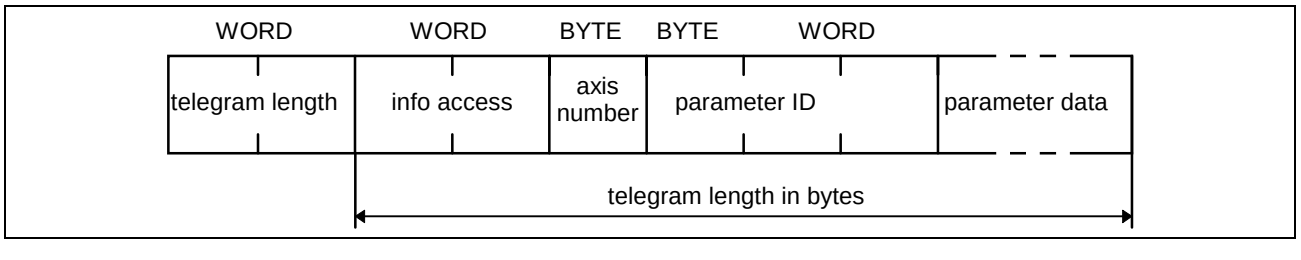


Fig. 2-3: Protocol of a parameter transmission

Telegram length

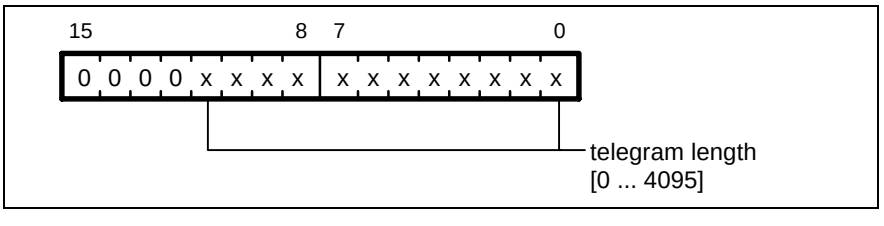


Fig. 2-4: Telegram length

Telegram length is given in bytes. If the transmit buffer has more than 1024 bytes, then the maximum telegram length is 1022.

Info access (parameter transmission)

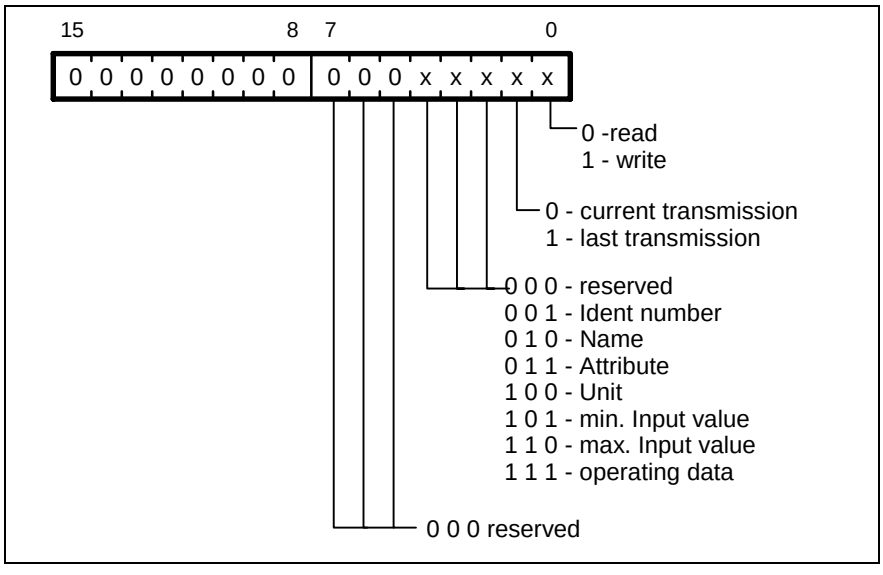

15
8
7
0
0 0 0 0 0 0 0 0
0 0 0 x x x x x
0 -read
1 - write
0 - current transmission
1 - last transmission
0 0 0 - reserved
0 0 1 - Ident number
0 1 0 - Name
0 1 1 - Attribute
1 0 0 - Unit
1 0 1 - min. Input value
1 1 0 - max. Input value
1 1 1 - operating data
0 0 0 reserved

Fig. 2-5: Info access (parameter transmission)

Axis number

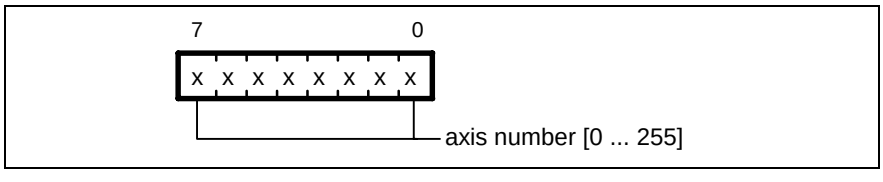


Fig. 2-6: Axis number

Parameter ID

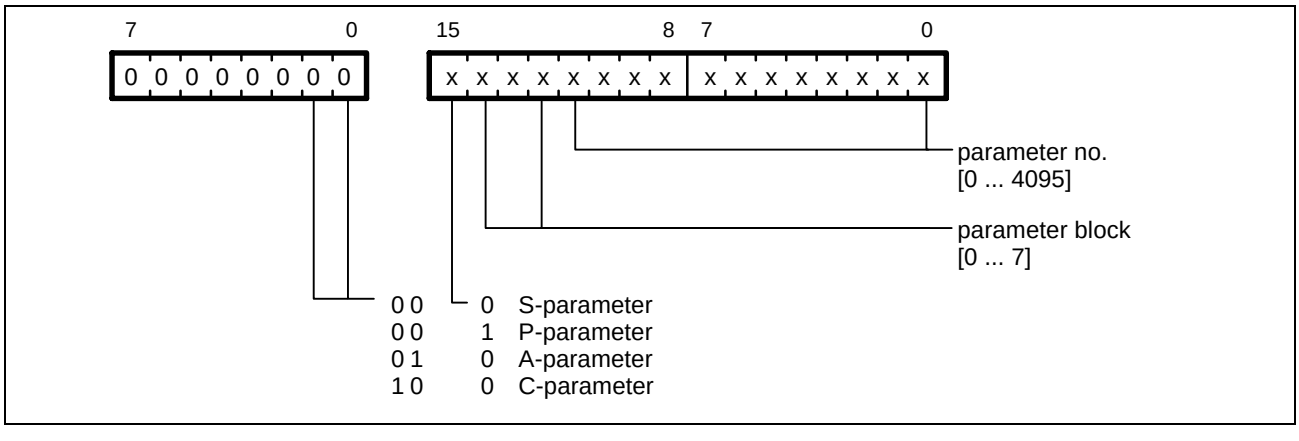


Fig. 2-7: Parameter ID (parameter transmission)

Parameter transmission sequence

During data transmission, a master/slave relationship exists between the PC and the CLC-P. The PC program requests transmission via an interrupt. The CLC-P acknowledges after executing the transmission.

Reading parameters

1.) During a read operation, the PC writes a data request to the transmit buffer.

2.) The PC then triggers a TRMT_REQ (by setting bit 1 in register CLC_IRQ) on the CLC-P.

3.) During successful transmission, the CLC-P writes the requested data to the receive buffer. The data header of the transmit buffer is then repeated by the CLC-P in the receive buffer.

4.) The CLC-P now triggers TRMT_RESP on the PC. It can now read the data.

3a) If the drive signals a transmission error, an error message is written to the receive buffer insted of the requested data.

4a) Instead of TRMT_RESP, the CLC-P now triggers ERROR_MSG (PC interrupt).

If the data is longer than the available memory location, then the CLC-P sets the ***transmission active*** bit in the data header of the receive buffer.

In order to get the remaining segments of the data, steps 1(to 4) must be repeated until the transmission is over. This is signalled by **the *last transmission*** bit.

Writing the parameters

1.) During a write operation, the PC writes a data request to the transmit buffer. The data to be transmitted is written to the transmit buffer.

2.) The PC then sends a TRMT_REQ (by setting bit 1in register CLC_IRQ) to the CLC-P.

3.) During successful transmission, the CLC-P writes the requested data to the receive buffer.

4.) A TRMT_RESP is then triggered at the PC by the CLC-P. This confirms successful transmission.

3a) If the drive signals a transmission error, an error message is written to the receive buffer instead of the requested data.

4a) In lieu of TRMT_RESP, the CLC-P now triggers ERROR_MSG (PC interrupt).

If the data is longer than the available memory location, then the CLC-P sets the ***transmission active*** bit in the data header of the receive buffer.

In order to get the remaining segments of the data, steps 1 to 4 must be repeated until the transmission is over. This is signalled by the ***last transmission*** bit.

Example

Various transmission examples of the "hex dump" type are listed below. The contents of the transmit and receive buffers are given in words. All values are hexadecimal and in INTEL format.

Read access

A) Name of the parameter A-0-0003 for drive 1

Prompt from PC (transmit buffer):

06 00	0A 00	01 01	03 00	.. ..	.. ..	.. ..

Response from CLC-P (receive buffer):

1E 00	0A 00	01 01	03 00	13 00	13 00	53 79	6E 63	68 72	6F 6E	69 73	61 74	69 6F
				1)	2)	'S' 'y'	'n' 'c'	'h' 'r'	'o' 'n'	'i' 's'	'a' 't'	'i' 'o'

6E 73	61 72	74 00	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..
'n' 's'	'a' 'r'	't' '\0'										

1) The first word gives the programmed length of the name in bytes.

2) The second word gives the programmed length of the name in bytes.

The lengths are indentical because the names are write protected.

Note: The names of all A, S and P parameters end with '0'.

B) unit parameter C-0-0006

prompt from PC (transmit buffer):

06 00	12 00	00 02	06 00	.. ..	.. ..	.. ..

response from CLC-P (receive buffer):

10 00	12 00	00 02	06 00	05 00	05 00	55 2F	6D 69	6E 00	.. ..	.. ..	.. ..	.. ..
						'U' '/'	'm' 'i'	'n' '\0'				

1) The first word gives the programmed length of the name in bytes.

2) The second word gives the programmed length of the name in bytes.

The lengths are indentical because the names are write protected.

Note: The units of all A, S and P parameters end with '0'.

Write access

A) "position command offset" (A-0-0004) for drive 3

prompt from PC (transmit buffer):

0A 00	1F 00	03 01	04 00	F0 49	02 00	.. ..	.. ..	.. ..
				15.0000 degree				

acknowledgement from CLC-P (receive buffer):

06 00	1F 00	03 01	04 00	.. ..	.. ..	.. ..

B) "Addresses projected drives" (C-0-0002)

This parameter is of the "variable length" type. The programmed and programmable lengths are also sent, with each transmission, in bytes, in the first and second word of the data field.

prompt from PC (transmit buffer):

10 00	0F 00	00 02	02 00	16 00	63 00	01 00	02 00	03 00	.. ..	.. ..	.. ..
				1)	2)	add. dr.1	add. dr.2	add. dr.3			

1) The first word gives the programmed length of the name in bytes.

2) The second word gives the programmed length of the name in bytes .

acknowledgement from CLC-P (receive buffer):

06 00	1F 00	00 02	02 00	.. ..	.. ..	.. ..

Transmission error

A faulty parameter transmission is acknowledged by the CLC-P with error interrupt ERROR_MSG (see "Parameter transmission sequence", page 2-8). The error number 0x006 (= transmission error) is set in the error register ERROR_REG. The type of transmission error is transmitted in the receive buffer with an error code. The error code is entered in the first word of the data field of the buffer.

Transmission errors are:

- non-existent parameter numbers accessed,
- non-existent elements accessed,
- format violations and
- input limits exceeded.

The following error codes are defined:

Error code	Error message in serial protocol
0x0000	No error
0x0001	Service channel not open
0x0009	Incorrect access to element 0
0x00A0	"Non-permisible request" e.g., an access to S/P parameters in initialization mode
0x00B0	"Non-permissible element" e.g., write access only with element operating data
0x00C0	"Drive address not permitted" The drive address is larger than permitted or the drive in the SERCOS ring is not active (deactivated or not there)
0x00F0	"Fatal software error" A CLC internal error occurred during parameter transmission (see C-0-0041). It has affected data exchange.
0x1001	IDN not extant
0x1009	Incorrect access to element 1
0x2001	Name not extant
0x2002	Name transmission too short
0x2003	Name transmission too long
0x2004	Name cannot be changed

0x2005	Name presently write-protected
0x3002	Attribute transmission too short
0x3003	Attribute transmission too long
0x3004	Attribute cannot be changed
0x3005	Attribute presently write-protected
0x4001	Unit not extant
0x4002	Unit transmission too short
0x4003	Unit transmission too long
0x4004	Unit cannot be changed
0x4005	Unit presently write-protected
0x5001	Minimum input value not extant
0x5002	Minimum input value transmission too short
0x5003	Minimum input value transmission too long
0x5004	Minimum input value cannot be changed
0x5005	Minimum input value presently write-protected
0x6001	Maximum input value not extant
0x6002	Maximum input value transmission too short
0x6003	Maximum input value transmission too long
0x6004	Maximum input value cannot be changed
0x6005	Maximum input value presently write-protected
0x7002	Data transmission too short
0x7003	Data transmission too long
0x7004	Data cannot be changed
0x7005	Data presently write-protected
0x7006	Data smaller than minimum input value
0x7007	Data greater than maximum input value
0x7008	Data not correct
0x700C	"Data exceeds numeric range" The transmitted value is smaller than zero or greater than the "modulo value" (S-0-0103) in the case of a modulo axis
0x700D	"Data length cannot presently be changed" The data length in current mode cannot be changed
0x700E	"Data length cannot be changed" The length of the data is permanently write protected
0x8001	"Service channel presently busy (BUSY)" The desired access presently not possible as service channel is bus. Data transmission not executed.

Fig. 2-8: Operational errors during parameter transmission

Error message following request for a non-existent unit.

Example: response from CLC-P (receive buffer):

08 00	10 00	01 01	03 00	01 40		.. ..	.. ..
				error code			

2.5 Real-time data transmission

Transmission principle

The transmission of real-time data is controlled by the PC as master. Control occurs via bit 0in the control word CYC_DAT_ACCESS.

The PC writes its command value at any time into the real-time data of the DPRAM. It then sets bit 0 in the control word CYC_DAT_ACCESS to ’1’. The CLC accepts the value during the next SERCOS cycle, writes the current actual values in the real time data buffer and acknowledges the transmission cycle by clearing bit 0 in CYC_DAT_ACCESS. The actual values can now be read by the PC.

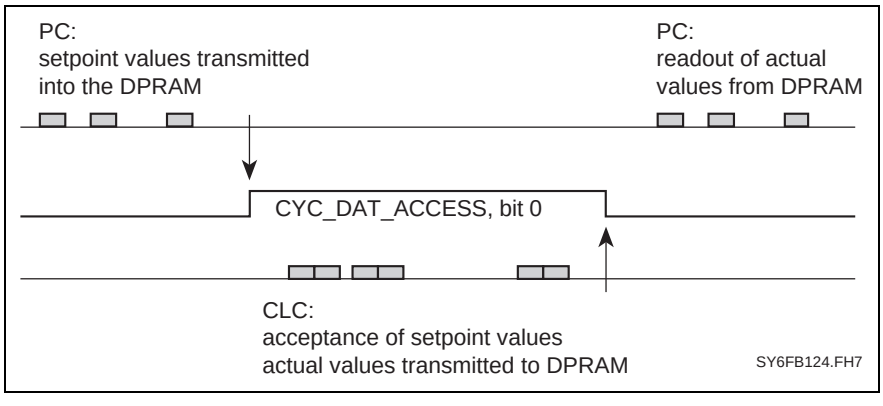


Fig. 2-9: Controlling the transmission of real-time data

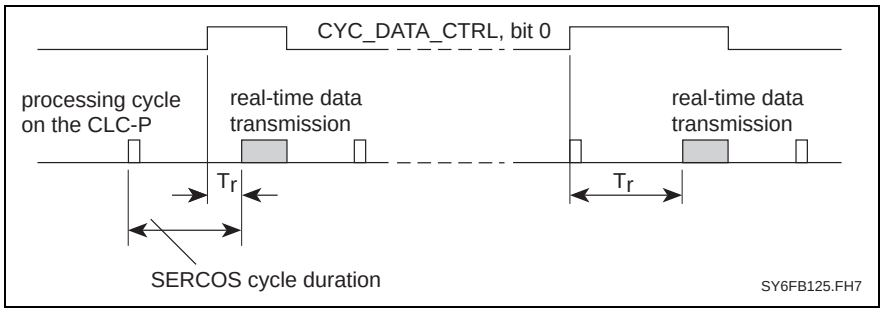


Fig. 2-10: Response time during the transmission of real-time data

The maximum response time of the CLC equals 1 SERCOS cycle.

Note: The CLC copies the configured data of all drives with each cycle.

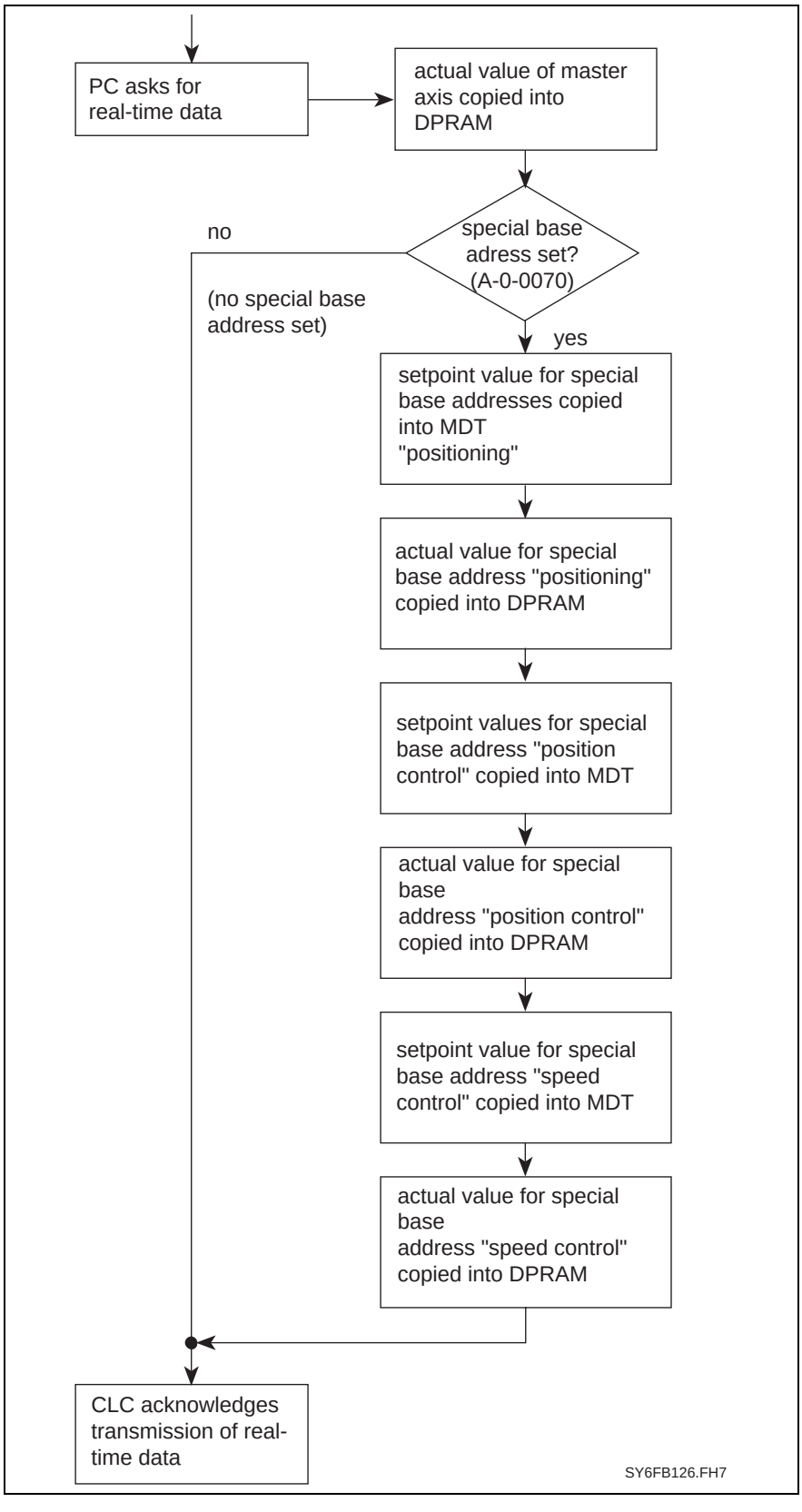

PC asks for real-time data
actual value of master axis copied into DPRAM
special base adress set? (A-0-0070)
no
(no special base address set)
yes
setpoint value for special base addresses copied into MDT "positioning"
actual value for special base address "positioning" copied into DPRAM
setpoint values for special base address "position control" copied into MDT
actual value for special base address "position control" copied into DPRAM
setpoint value for special base address "speed control" copied into MDT
actual value for special base address "speed control" copied into DPRAM
CLC acknowledges transmission of real-time data
SY6FB126.FH7

Fig. 2-11: Real time data transmission

Real time data buffer actual values

The real time data buffer actual values starts at the dual port RAM address.

CYC_DAT_ACT = 2 · PAR_BUF_SIZ Default: $800

(Also see "DPRAM storage", page 2-27.) This buffer is structured as follows:

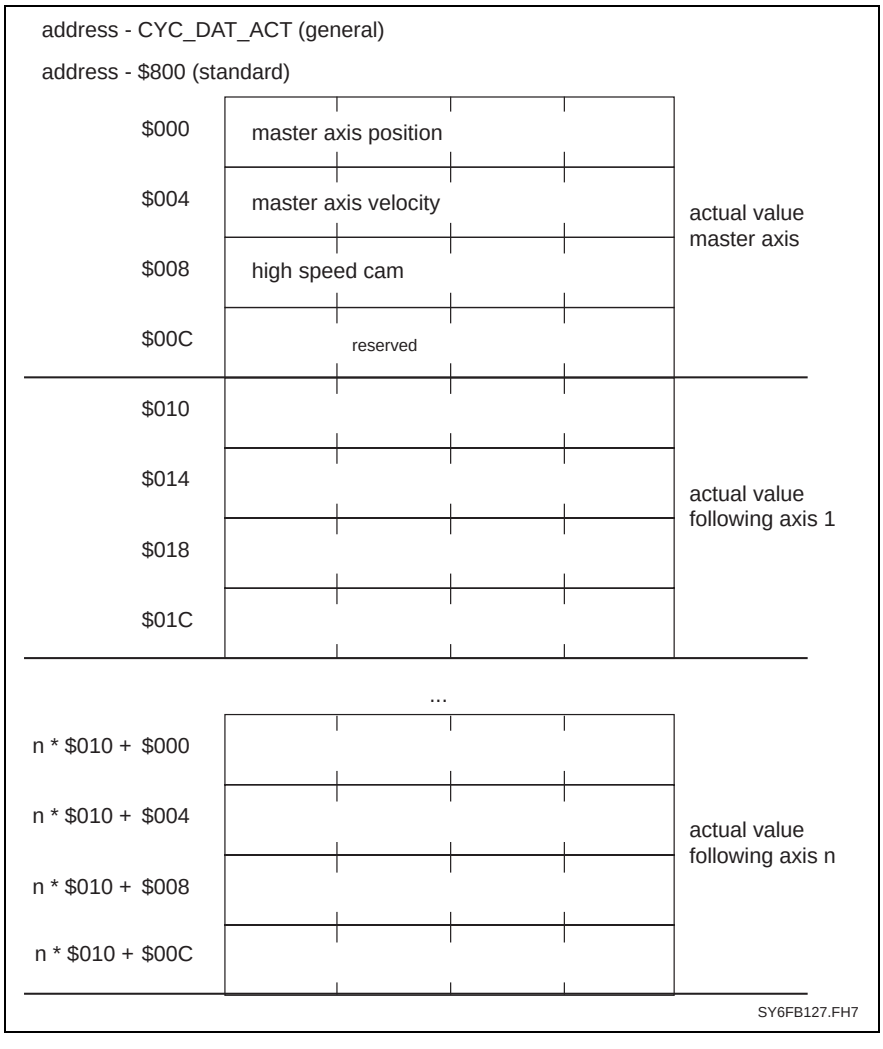


Fig. 2-12: Structure of the real time data buffer actual values

If the standard size CYC_BUF_SIZE = 256 is set for the real time data buffer, then the maxium drive address it can specify is 31.

Note: Generally applies: maximum drive address = (CYC_BUF_SIZE / 8) - 1

Real time data buffer command value

The real time data buffer actual values starts at the dual port RAM address

CYC_DAT_COM = 2 · PAR_BUF_SIZ + CYC_BUF_SIZE Default: $A00

(Also see "DPRAM storage", page 2-27) This buffer is structured as follows::

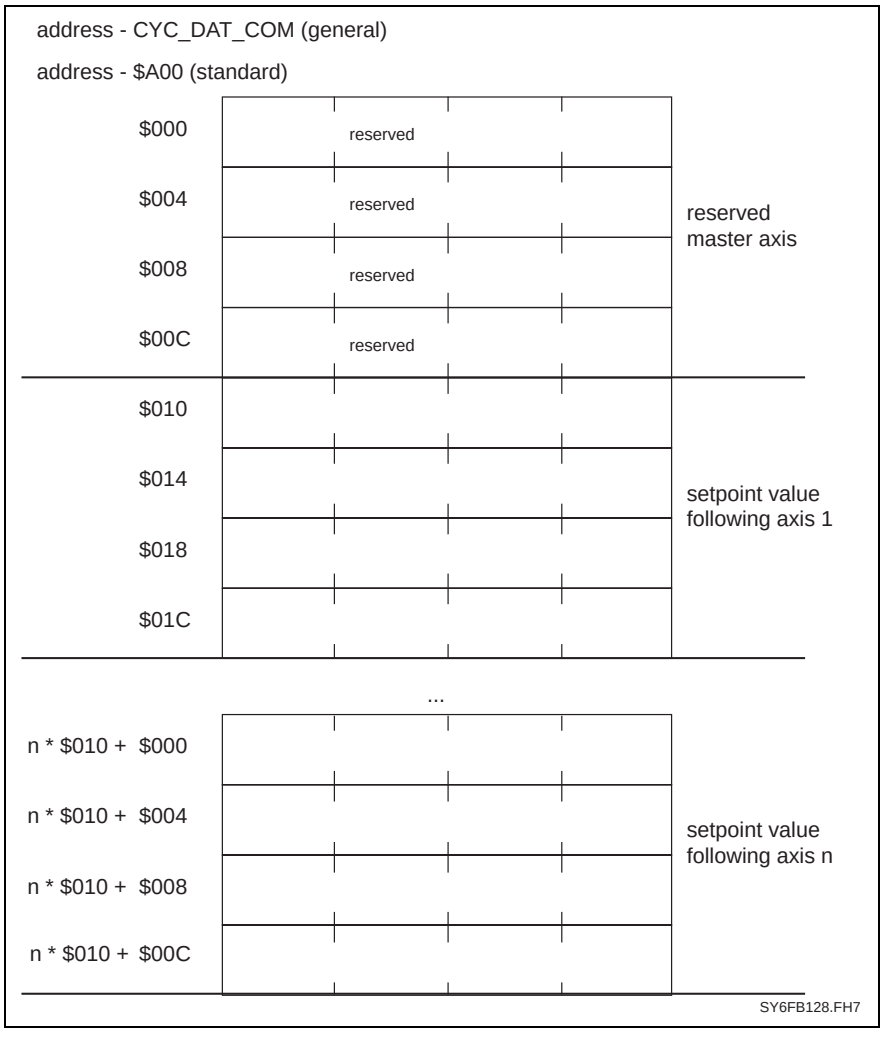


Fig. 2-13: Structure of the real time data buffer command value

If the standard size CYC_BUF_SIZE = 256 is set for the real-time data buffer, then the maximum drive address it can specify is 31.

Note: Generally applies: maximum drive address = (CYC_BUF_SIZE / 8) - 1

Cyclical parameter of the master axis

Master axis actual values: The master axis position within the real time data buffer actual value has the following structure:

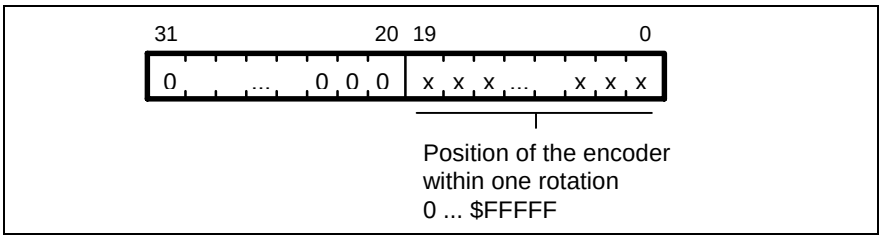


Fig. 2-14: Structure of the master axis position within the real time data buffer

Master axis speed in the real time data buffer-actual values is given in

$$\text{the unit of the master axis speed} = \frac{\text{crements}}{\text{cycletime}}$$

The definition of the increments is depicted in the figure above. The cycle time is outilned in parameter "SERCOS cycle time" (S-0-0002) and generally equals 2ms.

Example:

$$\text{master axis position LSB} = \frac{360^\circ}{2^{20}} = 0.0003433^\circ$$

$$\text{master axis speed LSB} = \frac{1}{2^{20}}\frac{U}{2ms} = 0.0286\frac{U}{min}$$

Fig. 2-15: Example: Master axis speed in the real time data buffer-actual values

Real-time data of the special operating mode positioning

For each drive operating in the special operating mode, position control, command or actual values can be transmitted by the CLC-P between the real-time data buffer and the drive. These parameters are decribed below.

Actual values of the special operating mode positioning

The real-time data configured in parameter A-0-0071 have the permanent address depicted below

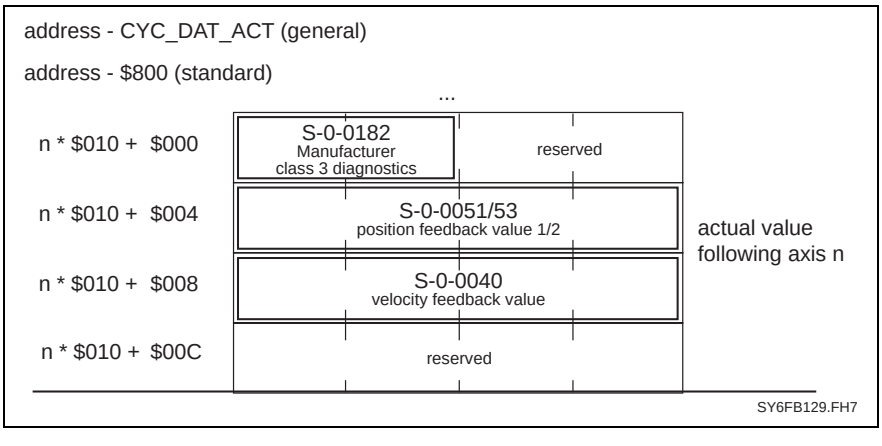


Fig. 2-16: Addresses of the actual values of the special positioning mode

Command values of the special operating mode positioning

The real time data configured in parameter A-0-0071 have the permanent addresses depicted below:

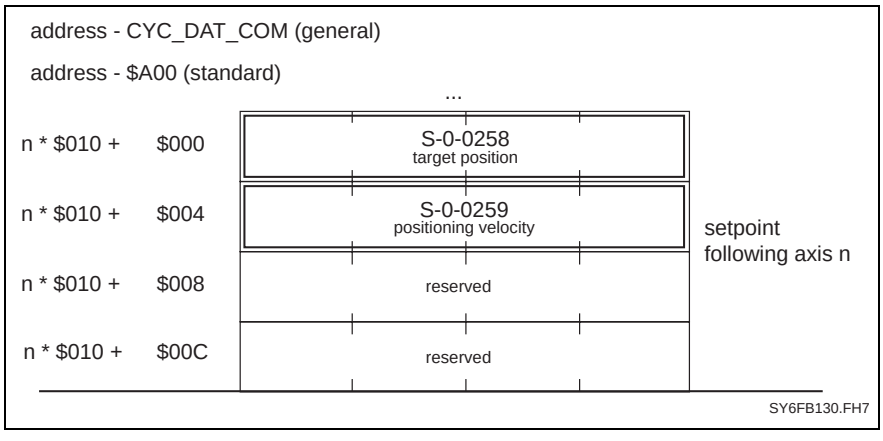


Fig. 2-17: Addresses of the command values of the special mode

Real-time data of the special operating mode position control

For each drive operating in the special operating mode, position control, command or actual values can be transmitted by the CLC-P between the real-time data buffer and the drive. These parameters are described below.

Actual values of the special operating mode position control

The real-time data configured in parameter A-0-0072 have the permanent addresses depicted below.

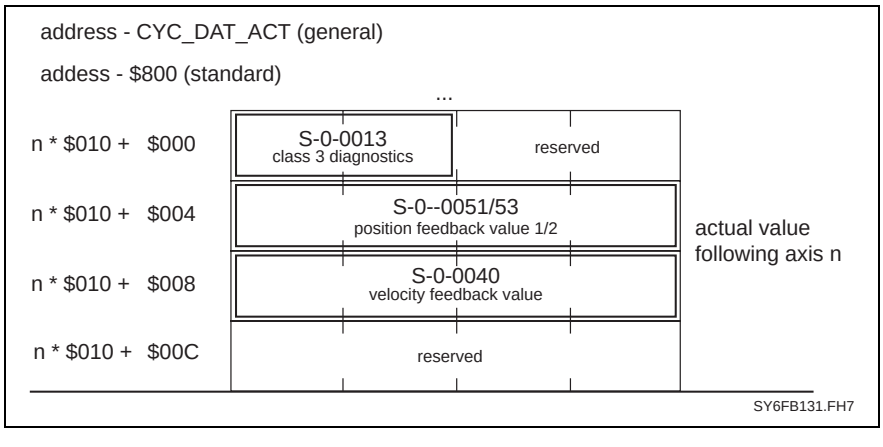


Fig. 2-18: Addresses of the actual values of position control mode

Command value of the special mode

The real-time data configured in parameter A-0-0072 have the permanent addresses depicted below.

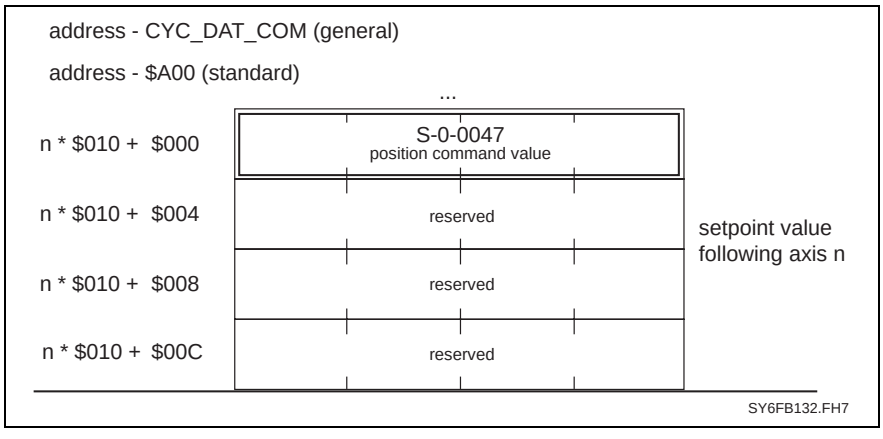


Fig. 2-19: Addresses of the command values of position control mode

Real-time data of the special operating mode speed control

For each drive operating in the special operating mode, speed control, command or actual values can be transmitted by the CLC-P between the real-time data buffer and the drive. These parameters are described below.

Actual values of the special mode speed control

The real-time data configured in parameter A-0-0073 have the permanent addresses depicted below.

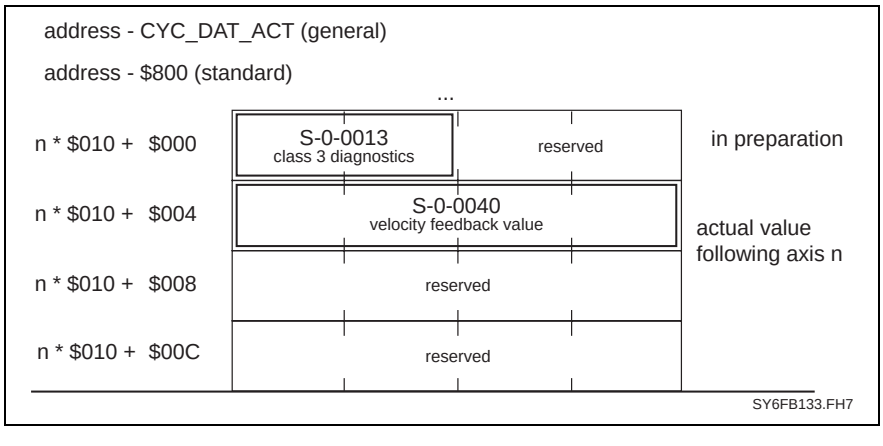


Fig. 2-20: Addresses of the actual values of speed control mode

Command value of the special operating mode speed control

The real-time data configured in parameter A-0-0073 have the permanent addresses depicted below.

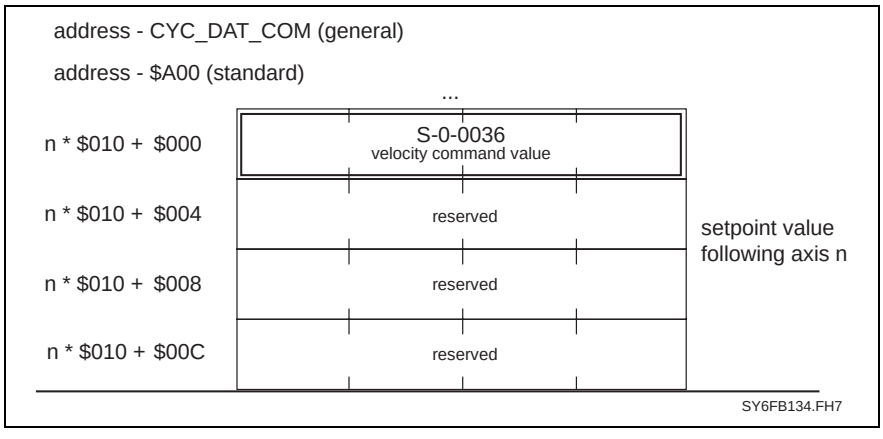


Fig. 2-21: Addresses of the actual values of speed control mode

2.6 I/O transmission

See functional description, section 4: "Internal and external I/O logic"

2.7 Mode changeover

The sequence of the switching between parameter and operating modes is as follows:

1.) The PC writes the new mode into register PC_MODE (address $FF8).

2.) With MODUS-IRQ, the switching command is transitted to the CLC-P.

3.) The CLC-P, upon successful change, writes the current mode into register CLC_MODE (address $FFA).

4.) The CLC-P in turn acknowledges the switching with MODUS_IRQ.

Note: If switching is not possible, then a mode other than the requested one is transferred. In this case, the CLC_MODE register should be checked!

Note: The CLC does not permit phase reset from operating mode with applied drive enable signal and/or turning master axis.

A phase switching will not be conducted if the phase specified is not permissible or a different switch procedure is still active.

That a switching was not possible is visible from the fact that there was a different value in register CLC_MODE than in register PC_MODE, and/or interrupt ERROR_MSG was set in register PC-IRQ.

In this case, there is an error code in register ERROR_REG.

If in the case of an error, the value "0" is in register ERROR_REG, then there has been a global error which prevents a phase switching. In this case, the registers SYNAX_ERR_CODE, SYNAX_DIAG_LW and SYNAX_DIAG_HW must be evaluated, as they are indicators of parameters C-0-0048 and C-0-0046.

Otherwise, if the phase switching was invalid, then a local diagnosis is stored in DPRAM (see the following table).

ERROR_REG	ERR_INFO	Diagnostics text
0000h	0000h	Phase switching successfully completed
0007h	0x8004h	incorrect phase (not specified in SERCOS interface)
0007h	0xD005	"Phase switching still active" A phase switching is presently not possible as a different once is still active.
0007h	0xD006	"Phase switching with drive enable not permissible" 'AF' has been set for at least one drive.
0007h	0xD007	"Phase switching with rotating master axis not permitted"

Fig. 2-22: Local diagnosis with phase switching via the dual port RAM

The individual error classes ERROR_REG and the possible CLC modes are outlined in the appendix (see "Appendix", page 2-23).

2.8 Pattern data transmission

Pattern data protocol

Depending upon the position of the master axis, the pattern computer transmits pattern data to the CLC-P.

Every data block contains information from the pattern computer which can be used to calculate a target position for all connected pattern controls - following drives. A detailed description of the data block structures as well as the chronological transmission sequence is outlined in the chapter "electronic pattern control".

The following depicts the structure of the data blocks:

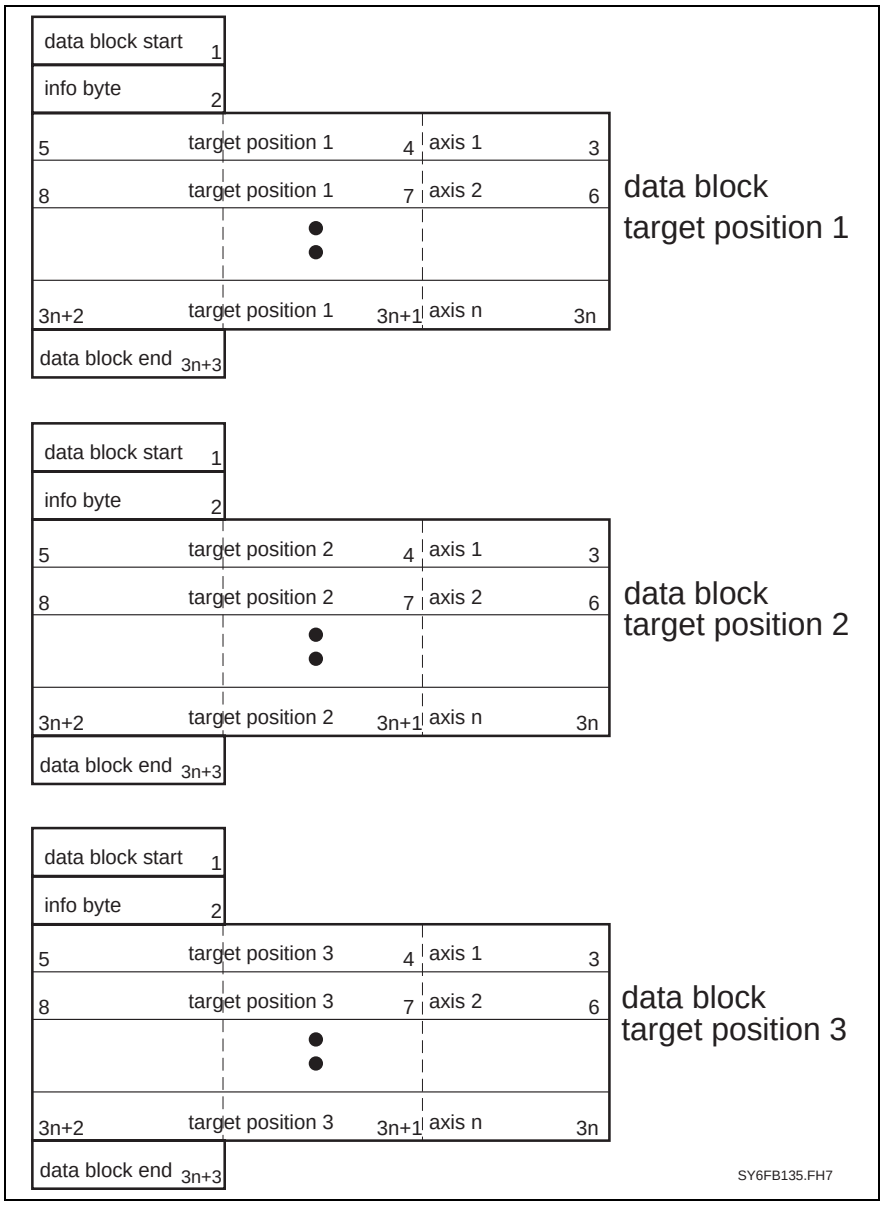

data block start 1
info byte 2
5 target position 1 4 axis 1 3
8 target position 1 7 axis 2 6
3n+2 target position 1 3n+1 axis n 3n
data block end 3n+3
data block target position 1
data block start 1
info byte 2
5 target position 2 4 axis 1 3
8 target position 2 7 axis 2 6
3n+2 target position 2 3n+1 axis n 3n
data block end 3n+3
data block target position 2
data block start 1
info byte 2
5 target position 3 4 axis 1 3
8 target position 3 7 axis 2 6
3n+2 target position 3 3n+1 axis n 3n
data block end 3n+3
data block target position 3
SY6FB135.FH7

Fig. 2-23: Structure of the data blocks

Pattern data transmission sequence

The CLC-P prompts, with the use of an interrupt, a pattern data transmission. The PC transmits the pattern data and then the CLC-P acknowledges after the transmission is executed.

Pattern data transmission sequence is as follows:

1.) The CLC-P requests the transmission of a pattern data set with PATTERN_REQ_A or PATTERN_REQ_B - interrupt.

2.) The PC writes a complete pattern data set into the pattern data buffer.

3.) The PC sets a PATTERN_RDY interrupt at the CLC-P after finishing the writing process.

4.) The CLC-P acknowledges successful completion and processes the pattern data by triggering a PATTERN_ACK interrupt.

A pattern data set is made up of three data blocks, i.e., target positions 1 to 3, for all drives in the synchronization pattern control (for either range A or B).

If the CLC-P sets a PATTERN_REQ_B, then the pattern data et for range B must be transmitted, i.e., the master axis is in range A.

If the CLC-P recognizes a transmission error, then the pattern data transmission (instead of PATTERN_ACK) is acknowledged with an error interrupt. In this case, no PATTERN_REQ comes from the CLC-P until the error is cleared.

The ERR_CODE register then contains error code 12. Register ERR_INFO contains an error number which must still be specified.

The following schematically depicts pattern data transmission.

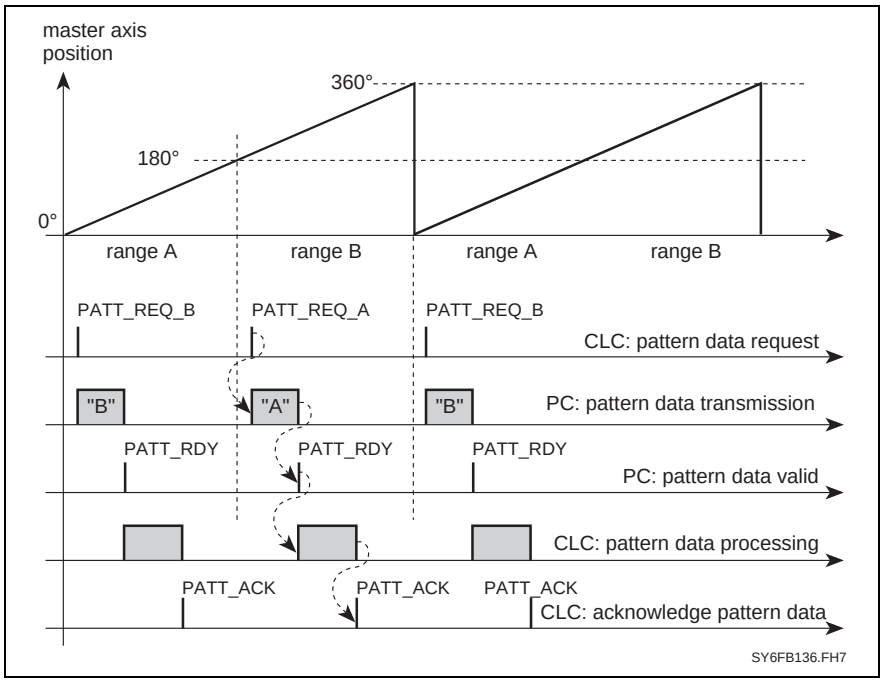


Fig. 2-24: Pattern data transmission sequence

Transmission of following pattern data set (12 bytes):

0A	29	00	14	00	00	32	10	00	28	20	17

Example: The following sequence (12 bytes) must be in the dual port RAM.

0A	29	00	14	00	00	32	10	00	28	20	17

Note: A pattern data transmission which uses words must use the Motorola format!

If the pattern data are transmitted in words, then make sure that the bytes in the dual port RAM, which are to be transmitted, are in the proper order.

With those computers that work with the Intel format, the following six words must be written into the dual port RAM:

0x290A 0x1400 0x0000 0x1032 0x2800 0x1720

The dual port RAM must then have the following sequence (12 bytes):

0A	29	00	14	00	00	32	10	00	28	20	17

2.9 Appendix

Installation ISA bus (CLC-P01)

Module CLC-P01

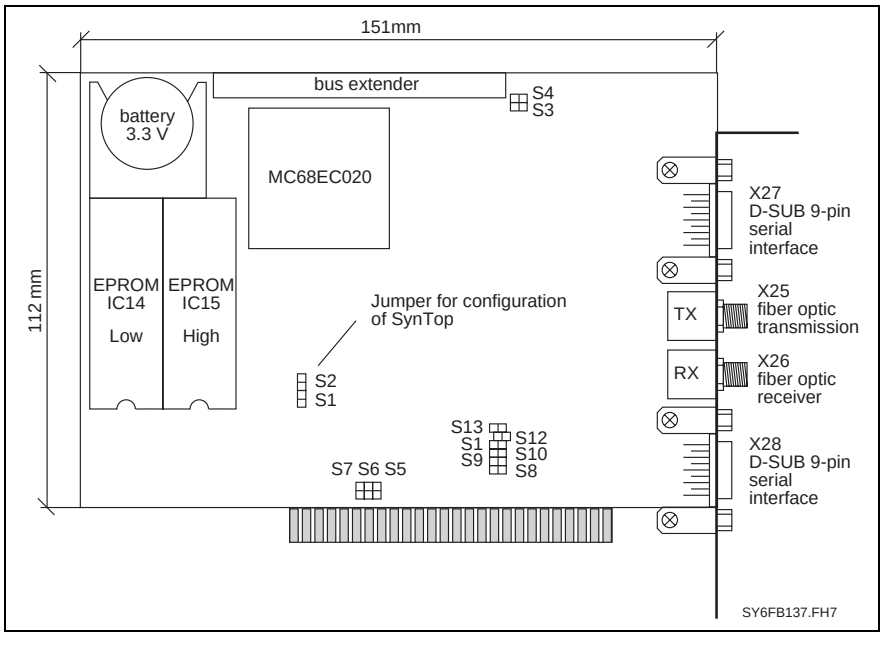


Fig. 2-25: Module CLC-P01

Settings at factory

S5 fitted	⇒	IRQ 2 (IRQ 9)
S8, 9, 11 fitted	⇒	PC - base address D000:0000
S1/S2 not fitted	⇒	SynTop at X27 (default parameter)

Base address DPRAM

The base address of the dual port RAM can be set via the four jumpers

S8 S9 S10 S11

The following base addresses have been configured:

S11	S10	S9	S8	Base address segment: offset
Br.	Br.	Br.	Br.	not permitted (VGA)
Br.	Br.	Br.	—	not permitted (VGA)
Br.	Br.	—	Br.	C000:8000
Br.	Br.	—	—	C000:C000
Br.	—	Br.	Br.	D000:0000
Br.	—	Br.	—	D000:4000
Br.	—	—	Br.	D000:8000
Br.	—	—	—	D000:C000
—	Br.	Br.	Br.	E000:0000
—	Br.	Br.	—	E000:4000
—	Br.	—	Br.	E000:8000
—	Br.	—	—	E000:C000
—	—	Br.	Br.	not permitted (BIOS)
—	—	Br.	—	not permitted (BIOS)
—	—	—	Br.	not permitted (BIOS)
—	—	—	—	not permitted (BIOS)

Fig. 2-26: DPRAM base addresses

Setting the hardware interrupts (PC)

The following interrupts can be set:

S5	S6	S7	Interrupt
Br.	—	—	IRQ 2 (IRQ 9)
—	Br.	—	IRQ 3
—	—	Br.	IRQ 5

Fig. 2-27: Interrupts

Installation PC-104 (CLC-P02)

Module CLC-P02

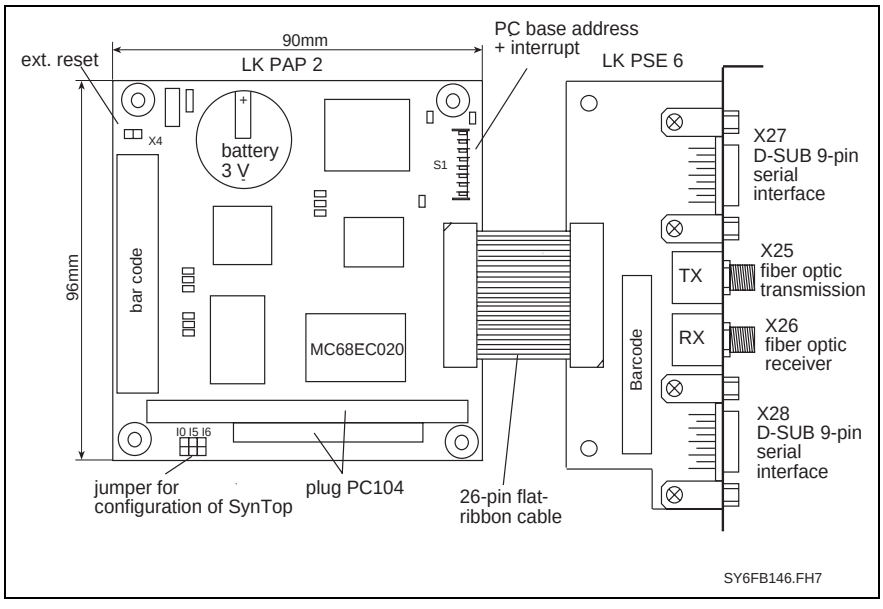


Fig. 2-28: Module CLC-P02

Note: When inserting the module make sure that the PC/104 connector is not laterally displaced.

Settings as of factory

S1.5, S1.6, S1.7, S1.8 OFF ⇒ no IRQ

S1.2, S1.3, S1.4 ON, S1.1 OFF ⇒ PC base address D000:0000

I0/I5/I6 not fitted ⇒ SynTop on X27 (default parameter)

Jumper I0, I5, I6

The card in flash programming mode can be forced with jumper I0.

Jumpers I5 and I6 are used to configure SynTop. In this case, I5 is jumper S1 on the CLC-D and 16 is jumper S2 on the CLC-P01.

Base address DPRAM

The base address of the dual port RAM can be set with the DIP switches

S1.-1 S1.2 S1.3 S1.4

Note: Hereinafter „ON“ DIP switch means downwards (not OPEN). „OFF“ means upwards (OPEN).

The following base address can be configured:

S1.1	S1.2	S1.3	S1.4	Base address segment:offset
OFF	ON	ON	ON	D000:0000
OFF	ON	ON	OFF	D000:2000
OFF	ON	OFF	ON	D000:4000
OFF	ON	OFF	OFF	D000:6000
OFF	OFF	ON	ON	D000:8000
OFF	OFF	ON	OFF	D000:A000
OFF	OFF	OFF	ON	D000:C000
OFF	OFF	OFF	OFF	D000:E000
ON	ON	ON	ON	E000:0000
ON	ON	ON	OFF	E000:2000
ON	ON	OFF	ON	E000:4000
ON	ON	OFF	OFF	E000:6000
ON	OFF	ON	ON	E000:8000
ON	OFF	ON	OFF	E000:A000
ON	OFF	OFF	ON	E000:C000
ON	OFF	OFF	OFF	E000:E000

Fig. 2-29: Base addresses of DPRAM CLC-P02 (PC/104)

Hardware interrupt (PC) settings

The following interrupts can be set with the DIP switch.

S1.5 S1.6 S1.7 S1.8:

S1.5	S1.6	S1.7	S1.8	Interrupt
ON	OFF	OFF	OFF	IRQ 15
OFF	ON	OFF	OFF	IRQ 12
OFF	OFF	ON	OFF	IRQ 11
OFF	OFF	OFF	ON	IRQ 10

Fig. 2-30: Interrupts

DPRAM storage

Overview

All addresses reference the DPRAM base address.

Address (standard)	16 bit word width	Size (standard)	Size (general)
$000	Parameter transmit buffer	512 words	PAR_BUF_SIZE
$400	Parameter receive data-puffer	512 words	PAR_BUF_SIZE
$800	Real-time data buffer actual values	256 words	CYC_BUF_SIZE
$A00	Real-time data buffer command value	256 words	CYC_BUF_SIZE
$C00	Pattern data buffer	128 words	PAT_BUF_SIZE
$D00	Binary inputs	128 words	
$E00	Binary outputs	128 words	
$F00	Identification text	18 words	
$F24	DPRAM-register	108 words	
$FFC	PC_IRQ	1 word	
$FFE	CLC_IRQ	1 word	
$1000 (only PC/104)	Expansion binary inputs	256 words	
$1200 (only PC/104)	Expansion binary outputs	256 words	
$1FFC (PC/104)	CLC_IRQ	1 word	
$1FFE (PC/104)	PC_IRQ	1 word	

Fig. 2-31: Overview

Note: If the PC conducts its own DPRAM test prior to initialization interrupt INIT_REQ, then the address as of Offset $F00 may not be written into.

Parameter transmit buffer

in preparation

Parameter receive buffer

in preparation

Pattern data buffer

in preparation

Binary I/Os

in preparation

Identification text of the CLC-P

Either

Indramat GmbH, CLC-P: Dual-Port-RAM, CLC*DP-SY*-06VRS

or

"CLC EPROM defective" (see fault number 16)

or

"CLC SRAM defective" (see fault number 17)

DPRAM-register

Address	Designation	Function
$FFA	CLC_MODE	The CLC-P writes its current mode in this register.
$FF8	PC_MODE	The PC writes the default of the CLC-P mode in this register.
$FF6	—	Reserved
$FF4	PAT_BUF_SIZE	Size of the pattern data buffer Default: 128 words
$FF2	CYC_BUF_SIZE	Size of the real time data buffer Default: 512 words
$FF0	PAR_BUF_SIZE	Size of the parameter data buffer, send and receive buffers have the same length. Default: 512 words
$FEE	DPRAM_CONF	This register decides whether the standard memory allocation or a cofigured memory allocation of the DPRAM will be used 0: standard-buffer 1: configured buffer **This register must always be written before an initialization interrupt!**
$FEC	—	Reserved
$FEA	ERROR_REG	Error register If an error is detected on the CLC-P, then the CLC-P triggers an error IRQ. The register is used to transmit an error code or error class: ERROR_REG = 6 error with parameter transmission ERROR_REG = 7 error with mode switching
$FE8	ERR_INFO	Contains additional information with error (see section "Transmission error", page 2-10)
$FE6	CMD_REQ1	Reserved
$FE4	CMD_REQ2	Reserved
$FE2	CMD_RESP	Reserved
$FE0	TRMT_MODE	This register specifies the transmission mode of the data (parameter). This register only used in special appliations. In all common applications is TRMT_MODE = 0. Default: 0
$FDE	CYC_DAT_ ACCESS	This register is used to control the PC access to the real-time data buffer. The register contains the following information: 0 = 0: access to real time data buffer locked

		Bit 0 = 1: access to real time data buffer permitted
$FDC	SYNAX_ERR_ CODE	This register contains the contents of parameter "SYNAX error number" (C-0-0048). It is updated only prior to setting the PC-IRQ.
$FDA	SYNAX_DIAG_ HW	The high-word of parameter "diagnosis info" (C-0-0046) is in this register. It is updated prior to setting the PC-IRQ.
$FD8	SYNAX_DIAG_ LW	The low-word of parameter "diagnosis info" (C-0-0046) is in this parameter. It is updated prior to setting the PC-IRQ.
$FD6	TRANSFER_ STATUS	All the interrupts of the CLC_IRQ which it conducts are secured in this registered- This actuation of a PC_IRQ clear the relevant bit out of TRANSFER_STATUS. Thus means it can be directly monitored whether a phase switching is active or how many requests can be conducted parallel.

Fig. 2-32: DPRAM-Register

Interrupt register

Address	Designation	Function
$FFE (ISA bus) $1FFC (PC/104)	CLC_IRQ	An interrupt is triggered on the CLC-P if the PC writes into this register. The register is reset after the CLC-P has processed the interrupt. It contains the following information: Bit 0 = 1: initialization Bit 1 = 1: transmit request Bit 2 = 1: pattern response Bit 3 = 1: mode request Bit 5 = 1: reserved
$FFC (ISA bus) $1FFE (PC/104)	PC_IRQ	An interrupt is triggered on the PC if the CLC-P writes into this register. The register is reset after the PC has processed the interrupt. It contains the following information: Bit 0 = 1: initialization Bit 1 = 1: transmit response Bit 2 = 1: pattern acknowledgement request Bit 3 = 1: code response Bit 4 = 1: error message Bit 5 = 1: reserved Bit 6 = 1: not ready signal (Busy) Bit 7 = 1: pattern request range A Bit 8 = 1: pattern request range B Bit 14 = 1: message about a warmstart of the CLC-P Bit 15 = 1: invalid message request

Fig. 2-33: Interrupt register

CLC modes

The possible modes of the CLC-P are:

Content of PC_MODE / CLC_MODE	Definition
$0000	Inactive mode (= SERCOS Phase 0) access to A and C parameters possible, no access to S and P parameters
$0002	Parametrization mode (= SERCOS Phase 2) read/write access to all parameters possible. Exception: those parameters that are generally write protected. (Example: rated current of amplifier)
$0004	Operating mode (= SERCOS Phase 4) Write access only to Online-Parameters possible. All other parameters only read access.
$0001	SERCOS Phase 1 (for test purposes only)
$0003	SERCOS Phase 3 (for test purposes only)
$0005	Zero bit stream (for test purposes only)
$0006	Steady light (for test purposes only)

Fig. 2-34: Operating modes of the CLC-P

3 ARCNET interface

3.1 Introduction

This section of describes the serial user interface ARCNET of the Indramat CLC-D control card.

With this interface

- parameter transmissions
- switchings between operating and parametrization mode
- and digital input/output transmissions are possible.

The serial interface can be used as a point-to-point connection, as a bus via a plug-in card.

The serial user interface supports the user data transmitted in a telegram as well as the Motorola and Intel formats. These data formats differentiate in terms of the serial sequence of the individual bytes of 2 byte and 4 byte data.

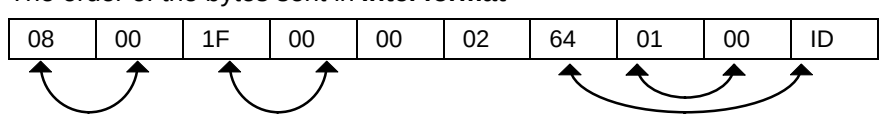
Example: The logical order of the data:

00	08	00	1F	00	02	1D	00	01	64
word		word		byte	byte	long (double word)			

The order of the bytes sent in **Motorola format**

00	08	00	1F	00	02	1D	00	01	64

The order of the bytes sent in **Intel format**



Note: Parameter "host communication - control word" (C-0-0033) is available to configure the serial interface.

3.2 ARCNET coupling with data exchange protocol

The following significant points are outlined in the general ARCNET specifications:

- ARCNET is a token-passing oriented network based on a coaxial cable with a gross data transmission rate of 2.5 Mbits/second.
- An ARCNET network can be made up of upto 255 interface connections with equality of access whereby each interface connection can communicate with all others.
- ARCNET interface connections are realized with ARCNET controllers which process the elementary ARCNET protocol without the need for a host computer.

- ARCNET controllers independently check whether packages sent were actually transmitted without any errors. This means that it is not necessary to run an additional check at a higher protocol level.
- Two different package types can be transmitted in ARCNET:
  - the length of short packes ranges between 1 and 253 bytes,
  - long packages range between 25 and 508 bytes.
  Packages with a length between 254 and 256 bytes must be sent as long packages with the corresponding number of fill bytes.
- Packages can be sent to a specific or all ARCNET switchons (broadcast news). This broadcast message is not, however, acknowledged and is therefore not secured.
- Each ARCNET controller, and thus every physical ARCNET interface connection has - comparable with an ethernet address - a definite ARCNET address.

The ARCNET connection to SYNAX is only available with a CLC-D, together with a DAK or DAQ daughter board.

SYNAX realizes an ARCNET coupling with the settings:

Data rate Data rate is set at 2.5 MBits/second.

Extended timeout Extended timeout is set at the default value. Reconfiguration time thus equals 840 ms.

Package length Short and long packages are allowed. The CLC only sends short packages.

Messages Broadcast messages are not supported.

Number of NACKs 128 NACKs must be set.

Above and beyond the basic network functions which ARCNET controllers themselves perform, additional demands must be met. These are of described in the following sections.

The ARCNET interface is realized as a master/slave system on the CLC. The ARCNET partner is always the master. It sends command telegrams. This means that the CLC is always the slave. It sends response telegrams.

There are two forms of command telegrams:

- TO telegrams - data is sent
- FETCH telegrams, data is prompted

The CLC then responds:

- with a response telegram with data after a FETCH telegram
- or no response telegram after a TO telegram or a FETCH telegram with a logical error.

Every logical error occurring during the processing of a telegram is stored in parameter "serial interface error number" (C-0-0057). The current status must always be read. Successful telegram transmissions clear this parameter!

Note: The ARCNET coupling with data exchange protocol is activated in parameter "host communication - control word" (C-0-0033).

Transmission order

Data transmission with TO telegrams looks like this:

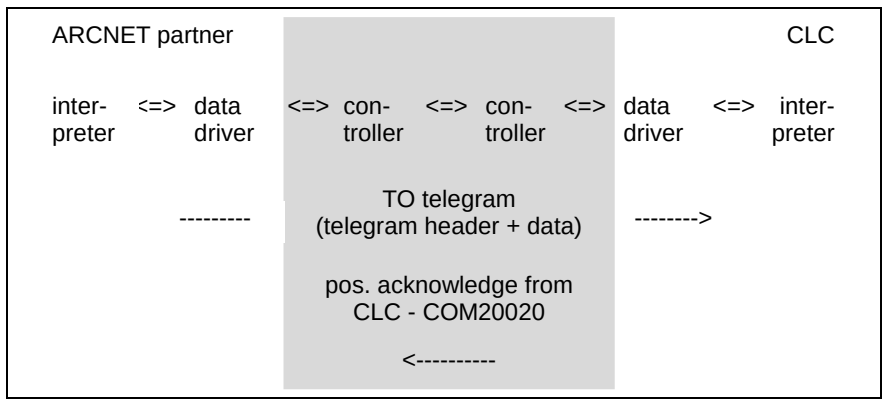


Fig. 3-1: Data transmission with TO telegrams

The CLC does not send response telegrams. The success of a TO telegram can be checked with a following FETCH telegram.

The transmitter of a telegram must be able to recognize the following:

- If the ARCNET controller signals successful transmission, then it is certain that the receiver has actually received the telegram (see the sequence described above).
- If the controller signals that the transmission contained an error because the receiver did either not respond or an error was detected in the checksum of the package (TMA[1]), then the transmission is started once more. If another TMA error occurs, then it useless to try again since either the receiver apparently does not exist or does not function, and an error thus ensues.
- If the controller signals that the transmission was completed with an error because there was no available space in the receiver buffer of the receiver (EXCNAK2), then the transmission must be repeatedly restarted over a specific period of time.This is necessary because the EXCNAK error is issued directly by the token rotation time and therefore is dependent upon the number of connected ARCNET controllers as well as network capacity. CLC internal processes with priority can also lock the receiver buffer of the controller. A constant send timeout is what is wanted, however.

The receiver cannot detect transmission errors because ARCNET controller sends no message with an error.

Data transmission with FETCH telegrams looks like this:

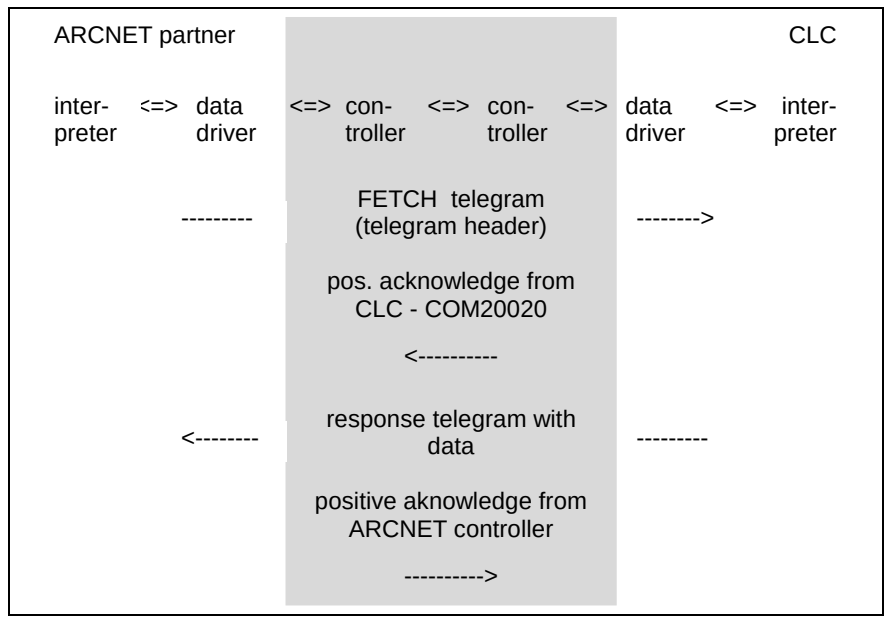


Fig. 3-2: Data transmission with FETCH telegrams

1) **TMA** is a flag in an internal register of the ARCNET controller. This flag indicates that the ARCNET address which was entered as receiver does not exist.

2) **EXCNAK** is a flag in an internal register of the ARCNET controller. This flag indicates that the ARCNET controller has tried 128 times to send the message to the ARCNET address which was entered as receiver. The receiver never had a free buffer, however.

The CLC only sends a response telegram if the interpreter has not detected a logial error in the FETCH telegram.

In the event of a logical error in the command telegram, the CLC discards this telegram and makes a note of the error number in parameter C-0-0057. These errors can be caused by the following:

Error no.	**Cause**
4	The following is valid for the prompt specified in the user data header: the prompt is unknown, or it is not yet supported.
5	The prompt cannot presently be completed as the required data queue is full.
6	The CLC has signaled an error for the A/C parameters.
7	The A2 has signalled an error for the S/P parameters.
8	Switch mode failed.
9	Data block specified not available.
10	The length of the data block does not agree with the configuration.
14	Error when writing I/O data (too many inputs).
21	The telegram header does not agree with the specification.
22	A following telegram was received but not expected, or a following telegram was expected but a normal telegram received.

	(Note: presently no support of following telegrams.)
23	The number of the user data does not agree with anticipated number.
24	The ARCNET partner is sending excessive NAKs.
25	The partner selected is not an ARCNET participant.

Fig. 3-3: Possible causes of errors

Note: Even error free telegrams are noted in C-0-0057 with error number 0. This means that the status of the last telegram can always be read in C-0-0057. For evaluating a logical error, a FETCH access to C-0-0057 is always thus needed after every TO command or unanswered FETCH telegram.

Telegram structure and content of the data exchange protocol

The data exchange protocol specified for the ARCNET interface integrates the Indramat protocol expansion (see 1.3 ff). It is laid out in such a way that a message oriented data exchange can take place with user data in different data types. It has its own protocol ID to permit the other data exchange protocols via the same physical bus.

Command telegram

A TO telegram is made up of a telegram header and data, a FETCH telegram only has a telegram header.

The telegram header is made up of 13 bytes and has two sections:

- The first seven bytes form the actual telegram header. This is comparable to the telegram header for the S5 interface (see "Telegram structure and content of the data exchange protocol", page 3-5).
- The final six bytes are the integral Indramat protocol expansion (see 1.3 ff). They also support the transmission of data blocks. It is placed ahead of the user data of each telegram that is not the folllowing telegram of a data transmission.

This part of the telegram header is dropped with following telegrams (see "Definition of the data blocks", page 3-13).

1	2	3	4	5	6	7
PK	logical NN		KB	DT	length	
	LB	HB			LB	HB

8	9	10	11	12	13	... n
info access		drive-ad-dress	parameter ID			data
LB	HB		Byte	LB	HB	only with TO-Tel.

1	protocol ID	(always 0x7f)
2	log. message no. low byte	(0x20 -0xFF in following telegrams 0x10 otherwise)
3	log. message no. high byte	(0x1C in following telegrams 0x80 otherwise)
4	command byte	(0 = TO telegram) (1 = FETCH telegram)
5	data type byte	(always 0x05 = Word-Array)
6	length in [Word] low byte	(telegram dependent)
7	length in [Word] high byte	(telegram dependent)
8	info access low byte	(see section 1.3)
9	info access high byte	(see section 1.3)
10	drive address	(with C parameter:0) (with A, S and P parameter: ≤ 40) (for data blocks > 40)
11	parameter ID (Byte)	(see section 1.3)
12	parameter ID (LB)	(see section 1.3)
13	parameter ID (HB)	(see section 1.3)
14 ff	data only with TO telgrams	

Note: In conjunction with ARCNET, bit 1 of info access (in progress transmission - see section 1.3) plays an important part in Indramat's protocol expansion as the data length of the telegram only relates to this telegram, not to the total data transmission.
If following telegrams still have to be sent in the case of long data blocks, then the first telegram of the data transmission must be designated a "transmission in progress". The transmission of the following telegram is thus controlled via the logical message number.

The telegram data are always interpreted as words per the protocol ID PK which is always located on an uneven address in the ARCNET RAM. The data length of the pure user data is limited to 123 words, following telegrams are not specified.

Reaction telegram

The prompted data are only sent back in response telegrams with FETCH telegrams. It is also made up of 13 bytes and contains the same information as does a command telegram.

1	2	3	4	5	6	7
PK	logical NN LB	HB	KB	DT	length LB	HB

8	9	10	11	12	13	... n
info access LB	HB	drive-addre ss	parameter ID Byte	LB	HB	data

1	protocol ID	(always 0x7f)
2	log. message no. low byte	(0x20 .. 0xFF in following telegrams 0x10 otherwise)
3	log. message no. high byte	(0x1C in following telegrams 0x80 otherwise)
4	command byte	(always 0 = TO telegram)
5	data type byte	(always 0x05 = Word-Array)
6	length in [Word] low byte	(telegram dependent)
7	length in [Word] high byte	(telegram dependent)
8	info access low byte	(as in FETCH telegram)
9	info access high byte	(as in FETCH telegram)
10	drive address	(as in FETCH telegram)
11	parameter ID (Byte)	(as in FETCH telegram)
12	parameter ID (LB)	(as in FETCH telegram)
13	parameter ID (HB)	(as in FETCH telegram)
14 ff	data	

The telegram data are always interpreted as words per the protocol ID PK which is always located on an uneven address in the ARCNET RAM. The data length of the pure user data is limited to 123 words, following telegrams are not specified.

Data structure as a short package

Every telegram is sent from one ARCNET controller to the other in a short package in the ARCNET configuration supported by SYNAX. A short package always has 256 bytes and contains the required ARCNET information in addition to the telegram data.

SID (Source ID) ARCNET address of the participant sending

DID (Destination ID) ARCNET address of the participant receiving

Count Data offset in short package as of where telegram data start.

An ARCNET package is always organized in such a way that the ARCNET specific section is located at the beginning of the package, the telegram data end at precisely the 256th byte of the package. The intermediate range is invalid. The data offset "count" references that byte of a short package where the data once again are valid. The data structure of a telegram with length n looks like this:

D0	SID (ARCNET address of the sender)
D1	DID (ARCNET address of the receiver)
D2	count = 256-n (short package) = data offset in ARCNET-RAM
D3	
D4	
...	
D Count	protocol ID: always **7Fh** (always uneven address)
D Count+1	logical message number LB: 10h
D Count+2	logical message number HB: 80h
D Count+3	command byte
D Count+4	data type byte: always **5h** (Word-Array)
D Count+5	data length LB
D Count+6	data length HB: always **0h**
D Count+7	info access LB
D Count+8	info access HB: always **0h**
D Count+9	address byte (drives, data blocks)
D Count+10	master ID byte
D Count+11	parameter ID LB
D Count+12	parameter ID HB
D Count+13	1. data word LB
D Count+14	1. data word HB
...	
D 254	m^{th} data word LB
D 255	m^{th} data word HB (end short package)

Fig. 3-4: ARCNET table 1

The fixed values of the data exchange protocol are highlighted. The following applies to the values which can be changed:

- logical NN LB: (0x20-0xFF in following telegrams, 0x10 otherwise)
- logical NN HB: (0x1C in following telegrams, 0x80 otherwise)
- command byte: 0 => TO telegram, 1 => FETCH telegram
- data length LB: length in [word] as of date "info access LB"
- info access LB: 1Fh => data write
  1Eh => data read
  other possible values see section 1.3
- address byte 0 => with C parameter,
  > 40 => with data blocks (as DB number),
  otherwise => drive address with A, S or P parameters
- master ID: 2 => C parameters
  1 => A parameters
  0 => others
- parameter ID: Ident number of the parameters; with P parameters, add value 8000 h
- data words:

Example 1: The ARCNET partner wants to change the fine adjustment (parameter A-0-0060) of drive 2.

D0	0A	(station number of the section computer)
D1	0B	(station number of the CLC)
D2	F1	(data offset: 241)
D3		
D4		
...		
D241	7F	(protocol ID)
D242	10	(logical message number LB)
D243	80	(logical message number HB)
D244	00	(command:"TO")
D245	05	(data type: word-array)
D246	04	(data length in word: LB)
D247	00	(data length in word HB)
D248	1F	(info access LB: operating data write)
D249	00	(info access HB: not used)
D250	**02**	**(address byte: drive 2)**
D251	01	(master ID byte: A parameters on the CLC)
D252	3C	(parameter ID LB: parameter number 60)
D253	00	(parameter ID HB: parameter number 60)
D254	**CE**	**(operating data LW LB: -50, i.e. insufficient control 0.5%)**
D255	**FF**	**(operating data LW HB: -50, i.e. insufficient control 0.5%)**

Fig. 3-5: ARCNET table 2

The data D0 to D3 are ARCNET specific. The telegram header of the data exchange protocol starts with D241. From D254, the operating data follows parameter A-0-0060 of drive 2.

The variable data bytes are highlighted. Up to drive address D250, this protocol data block remains the same for all write access to the fine adjustment of the drives.

The CLC sends no response to "TO" commands. The success of the transmission can be checked by the ARCNET partner by reading back the parameters.

Example 2: The ARCNET partner wants to know the general diagnosis flag (parameter C-0-0046) which is the only parameter configured in data block 101.

D0	0A	(station number of the section computer)
D1	0B	(station number der CLC)
D2	F3	(data offset: 243)
D3		
D4		
...		
D243	7F	(protocol ID)
D244	10	(logical message number LB)
D245	80	(logical message number HB)
D246	01	(command:"FETCH")
D247	05	(data type: Word-Array)
D248	03	(data length in Word: LB)
D249	00	(data length in Word HB)
D250	1E	(info access LB: operating data lesen)
D251	00	(info access HB: not used)
D252	65	(address byte: data block 101)
D253	00	(master ID byte: not used)
D254	00	(parameter ID LB:not used)
D255	00	(parameter ID HB: not used)

Fig. 3-6: ARCNET table 3

The data D0 to D3 are ARCNET specific. The telegram header of the data exchange protocol starts at D239. It contains no user data. The contents of the data block 101 are prompted in the header.

Response The CLC sends the requested diagnosis to the ARCNET partner.

D0	**0B**	**(station number of the CLC)**
D1	0A	(station number of the section computer)
D2	EF	(data offset: 239)
D3		
D4		
...		
D239	7F	(protocol ID)
D240	10	(logical message number LB)
D241	80	(logical message number HB)
D242	00	(command:"TO")
D243	05	(data type: Word-Array)
D244	05	(data length in Word: LB)
D245	00	(data length in Word HB)
D246	1E	(info access LB: as specified in prompt)
D247	00	(info access HB: not used)
D248	65	(address byte: as specified in prompt)
D249	00	(master ID byte: as specified in prompt)
D250	00	(parameter ID LB: as specified in prompt)
D251	00	(parameter ID HB: as specified in prompt)
D252	**00**	**(operating data LW LB: 65536,)**
D253	**00**	**(operating data LW HB: means)**
D254	**01**	**(operating data HW LB: error on)**
D255	**00**	**(operating data HW HB: of the CLC)**

Fig. 3-7: ARCNET table 4

Data D0 to D3 are ARCNET specific. The telegram header of the data exchange protocol starts at D239. The user data are made up of operating data. It is in the ARCNET RAM starting at D2523. Only the value of the operating data (**highlighted**) can change. Everything else remains the same.

How the SYNAX internal command processing affects ARCNET

The internal data driver of the CLC polls the interfaces and conducts the entered prompts to the CLC parameter handler or the SERCOS required data handler or the corresponding entities. These data handler complete their data management in a purely sequential fashion. This means that the data prompts are processed in order on the FIFO buffer. In this FIFO buffer, the data requests which arrive via the serial interface as well as the CLC internal prompts, queue.

The data handlers have a low-task priority, lower than the tasks of the control unit of the machine axis or the run up of the CLC. This means that the processing of data prompts by SYNAX is a non-deterministic process.

The following numbers should help clarify the processing times:

Transaction	Maximum processing time in [ms]
read I/O data	100
read drive parameters (max. 4 bytes)	200
read a S/P list of 246 bytes	400
read current phase	100
write I/O data	50
write drive parameters (max. 4 bytes)	150
write a S/P list of 246 bytes	350
change into parametrization mode	(2000 + C-0-0001)
change to parametrization mode	(500 (#drives))

Fig. 3-8: Clarification of processing times

Switching into operating mode requires the most time since the number of drives is directly involved in the time required. Because of the high priority of the run up task, it cannot be expected that a different task is performed during run up, e.g., checking current phase. Only with the I/O data can a deterministic behavior respective time be expected.

The way which telegrams are handled internally does not correlate with bus communications. The goal of communications via a bus, such as is the case with ARCNET, is to exchange data as quickly as possible with all participants (equal access).

Two aspects of this matter are relevant. On the one hand, the telegram should be processed as quickly as possible by the receiver. The limits are set by the above table in this case.

On the other hand, the telegram should be immediately accepted, the receiver buffer of the ARCNET controller must be released immediately. In this case, there are two CLC variations which adhere more closely to both principles.

Bit 2 in parameter "host communication - control word" (C-0-0033) is used to make this setting.

Polling mode

In polling mode, the CLC more or less adapts to the principle of internal data transport respective the ARCNET. The RI bit in the status register of the COM20020 is polled, a telegram is processed, internal functions executed, and then finally the receiver bufer of the controller is released. Since only one telegram at a time can be processed CLC internally, the ARCNET interface also works with this internal timing. Only with write errors, is the receiver buffer of the COM20020 released immediately after accepting a telegram because it is not necessary, in any case, for the CLC to send a response telegram. This means that a series of write accesses can be quickly performed, as described above.

Note: If a write access follows a read access too soon, then the response telegram of the read prompt could be lost.

From a CLC technical perspective, the polling mode is the most advantageous mode as it requires no additional internal storage of a telegram buffer. It hardly, however, complies with the bus principle. It is suited for all ARCNET coupling units in which only an ARCNET partner communicates with the CLC, and where the times of the above table are taken into account during cyclical data accessing.

If a quick telegram transmission is needed on a short-term basis, or if several ARCNET partners unsynchronously access the same CLC (multi-master coupling), then security problems may arise. This means that several prompts may be waiting within one ARCNET cycle, whereby the participants with short timeout durations (< 200 ms) could run into a timeout. The following then applies.

Interrupt mode

In interrupt mode, the RI bit of the status register is set on an interrupt of the COM20020. The telegram received is thus copied into a FIFO buffer for received telegrams and the receiver buffer of the COM20020 is released. This is interrupt controlled.The FIFO buffer has 32 telegrams, as described above.

Interrupt mode represents, with its FIFO buffer, the link between both principles. On the one hand it supports the bus concept of ARCNET, whilst on the other, it also has CLC internal processing. It can, of course, also be set where the polling mode is sufficient.

Note: If the data requests are continuously received via ARCNET in a sequence more rapid than the internal processing can permit, then even the interrupt mode cannot prevent that the receiver buffer of the COM20020 will, at some point, remain locked. An overflow of the FIFO buffer for the telegrams unavoidably occurs. As of this point, a quasi polling mode exists.
The processing times in interrupt mode can be extended so that other telegrams can be waiting in the FIFO buffer to be processed. This means that the response telegram of a read access, sent to check a write access, could arrive later than the ARCNET partner expects. If the timeout duration of the partner runs out, then it can repeat the read access. In this case, the CLC sends the expected response telegram twice, since the prompt was received twice. This should not confuse the ARCNET partner.

Definition of the data blocks

The following conditions apply to the data blocks:

- It is only possible to access data blocks in their entirety. It is not possible to access individual elements of the data blocks.
- The length of the data blocks is limited to the following bytes:

	short package	long package
data type 04/05 (byte/word array)	246	500
data type 06 (long array)	244	498

Predefined data blocks

There are predefined data blocks on the CLC destined for specific tasks:

Data block no.98: Terminate transmission with following telegrams

This data block is used to inform the CLC that a data transmission begun by the ARCNET partners with following telegrams is being terminated. The CLC then finishes off internal "clean-up work" and discards the incomplete data block and is then ready to start a new data transmission.

The data block can only be used in a SEND-telegram and contains no data.

ARCNET partner

1	2	3	4	5	6	7	8	9	10	11	12	13
0x7F	0x10	0x80	0x00	0x05	0x00	0x00	0x00	0x00	0x62	0x00	0x00	0x00
telegram header												

It makes sense to use this if the data line has physically broken down during a data transmission with following telegrams, if transmission is not yet running with stability or if the ARCNET unit has crashed.

DB no. 99 I/O data

Using this data block it is possible to set inputs via the serial interfaces and read outputs. The user data have a width of two bytes each. They are thus similar to the I/O data of a DEA. A maximum of 32 input or output words can be accessed.

Note: The use of data block 99 only makes sense when in operating mode (phase 4).

1. Example: write the CLC inputs

ARCNET partner:

1	2	3	4	5	6	7	8	9	10	11	12	13
0x7f	0x10	0x80	0x01	0x05	0x03	0x00	0x43	0x00	0x63	0x00	0x00	0x00
telegram header												

14	15	16	17
0xa5	0x5a	0x12	0x34
data			

In this example, we see two input words for I/O handling via serial interface. Both input values can be set as described above.

The following applies to writing inputs:

- If only the first word is accessed, then only one input value (bytes 11 and 12) need be accessed.
- If the data record is made up of more than two input values, then the superfluous data are ignored.
- I/O handling via serial/parallel interfaces uses WORD access. If only one bit is to be changed, then the other 15 must be transmitted with their old values.
- A write access in parametrization mode is always positively acknowledged by the CLC. The data are not assumed, however.
- It is only possible to write to inputs, not to read them.

Second example: Read CLC outputs

The CLC outputs look like this:

ARCNET partner:

1	2	3	4	5	6	7	8	9	10	11	12	13
0x7f	0x10	0x80	0x01	0x05	0x03	0x00	0x42	0x00	0x63	0x00	0x00	0x00
telegram header												

CLC:

1	2	3	4	5	6	7	8	9	10	11	12	13
0x7f	0x10	0x80	0x00	0x05	0x05	0x00	0x42	0x00	0x63	0x00	0x00	0x00
telegram header												

14	15	16	17
0xed	0xcb	0x5a	0xa5
data			

Two output words are configured in this example, via the serial interface, for I/O handling.

The following applies when reading outputs:

- When reading CLC outputs, all configured outputs are sent as data records. This means it is not possible to read an individual CLC output or a single output word.
- A read access when in parametrization mode always results in an empty data record.
- Outputs can only be read. It is not possible to write to them.

DB no. 100 switching modes

This data block supports the switching between operating and parametrization modes. It has a length of one word. The parameter can be read and written to. The data contents specify the current mode on the CLC, or it sets the mode to be switched into. Only two dta contents are legal.

2 : parametrization mode

4 : operating mode

Note: The CLC will only permits a mode switch when in operating mode if the master axis is standing and no drive enable signal is being applied at any drive.
A mode switch is not executed if the phase specified is not permissible or a different switch progression is still active.

Example:

Switching to operating mode:

ARCNET partner:

1	2	3	4	5	6	7	8	9	10	11	12	13
0x7f	0x10	0x80	0x00	0x05	0x04	0x00	0x83	0x00	0x64	0x00	0x00	0x00
telegram header												

14	15
0x04	0x00
data	

Reading current operating mode:

ARCNET partner:

1	2	3	4	5	6	7	8	9	10	11	12	13
0x7f	0x10	0x80	0x01	0x05	0x03	0x00	0x82	0x00	0x64	0x00	0x00	0x00
telegram header												

CLC:

1	2	3	4	5	6	7	8	9	10	11	12	13
0x7f	0x10	0x80	0x00	0x05	0x04	0x00	0x82	0x00	0x64	0x00	0x00	0x00
telegram header												

14	15
0x04	0x00
data	

Configurable data blocks

On the CLC 16 data blocks can be freely configured for the ARCNET interface. The configuration is effected via the 8 parameters "configuration list data block 101" (C-0-0058) to "configuration list data block 108" (C-0-0065). This corresponds to data block addresses 101 to 108

C-0-0058 "configuration list data block 101"	———>	data block no. 101
C-0-0059 "configuration list data block 102"	———>	data block no. 102
C-0-0060 "configuration list data block 103"	———>	data block no. 103
		...
C-0-0065 "configuration list data block 108"	———>	data block no. 108
C-0-0078 "configuration list data block 109"	———>	data block no. 109
		...
C-0-0085 "configuration list data block 116"	———>	data block no. 116

These parameters are lists of variable length. Data width equals four bytes. Every element of the list designates a parameter in the relevant data block and has the following structure (SYNAX format).

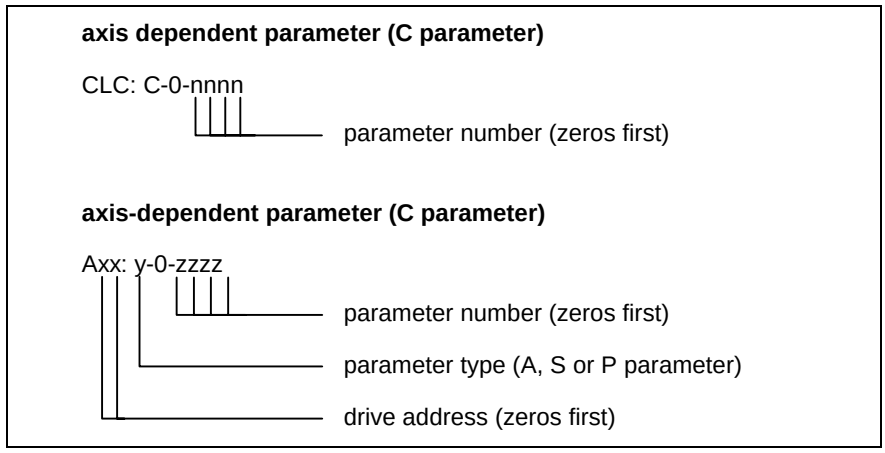

axis dependent parameter (C parameter)
CLC: C-0-nnnn
parameter number (zeros first)
axis-dependent parameter (C parameter)
Axx: y-0-zzzz
parameter number (zeros first)
parameter type (A, S or P parameter)
drive address (zeros first)

Fig. 3-9: Parameter structure

Example:

Configuration list data block 1	Axis no.	Parameter-ID	data length	Parameter name	Weighting	Example of data contents
A01:A-0-0004	1	A-0-0004	4 bytes	angle offset target value	0.0001°	10°
A02:A-0-0004	2	A-0-0004	4 bytes	angle offset target value	0.0001°	0.1°
A03:A-0-0060	3	A-0-0060	2 bytes	fine adjustment, additive	0.01%	3%
CLC:C-0-0006	-	C-0-0006	4 bytes	virtual master axis idle speed 1	0.0001rpm	300 rpm

Fig. 3-10: Example of configurable data blocks

The resulting contents of data block 101:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	
00	01	86	a0	00	00	03	e8	01	2c	00	2d	c6	c0	hex
A-0-0004 axis 1				A-0-0004 axis 2				A-0-0060 axis 3		C-0-0006 master axis				

Example of a transmission: a) write data: (See example above, data block 101 = 0x65)

Master writes:

1	2	3	4	5	6	7	8	9	10	11	12	13
0x7f	0x10	0x80	0x00	0x05	0x0a	0x00	0x1f	0x00	0x65	0x00	0x00	0x00
telegram header												

14	15	16	17	18	19	20	21	22	23	24	25	26	27	
00	01	86	a0	00	00	03	e8	01	2c	00	2d	c6	c0	hex
user data														

b) read data: (See example above)

Master prompts data:

1	2	3	4	5	6	7	8	9	10	11	12	13
0x7f	0x10	0x80	0x01	0x05	0x03	0x00	0x1e	0x00	0x65	0x00	0x00	0x00
telegram header												

Slave sends data:

1	2	3	4	5	6	7	8	9	10	11	12	13
0x7f	0x10	0x80	0x00	0x05	0x0a	0x00	0x1e	0x00	0x65	0x00	0x00	0x00
telegram header												

14	15	16	17	18	19	20	21	22	23	24	25	26	27	
00	01	86	a0	00	00	03	e8	01	2c	00	2d	c6	c0	hex
user data														

Notes on compiling configuration lists

The following must be noted when compiling a configuration list for transmitting data both efficiently and without error.

- The parameters are divided into four groups, viz., the C, A, S and P parameters. The A and C parameters are on the CLC, while the S and P parameters are on the drives. This means that accessing the S and P parameters will take longer as the CLC must first access these parameters via the SERCOS required data channel.
- Parameter groups can be mixed in any way desired within one data block. The number of S and P parameters should, with an eye towards the response tie, be limited to what is necessary. The S and P parameters of an axes should also, considering response time, not be arranged in sequence.
- There are three classes of parameters within each group:
  - Parameters that can only be read, actual values, for example (**S**: write protected)
  - Parameters that can always be read but only in parametrization mode can these be written into, e.g., synchronization mode (**B**: write protected in operating mode)
  - Parameters that can always be read and written into, e.g., command values (**K**: parameter not write protected)

The data blocks must be configured in such a way that no communications error can occur.

Data block access mode	**Legal parameter classes within a data block**	
only in read mode	S, B, K	see above
read in all modes and write only in parametrization mode	B, K	see above
read and write in all modes	K	see above

Fig. 3-11: Configuration of the data blocks

Handling S/P parameters when deactivating drives

In data blocks it is possible to configure A and C parameters of the CLC control as well as S and P parameters of the drive in any combination. To administer the data contents of a data block the data length of all configured parameters must be known CLC internally. Data lengths of S and P parameters are stored in the drives. If a drive is deactivated then it does not participate in communications via the SERCOS interface. The CLC cannot read out the length information.

Data blocks that access parameters on a deactivated drive must be transmittable without having to change the configuration. To support this, a list of "preferred parameters" is on the CLC. The list contains preselected S and P parameters and their lengths. The administration of a data block is thus basically also possible if not all addressed drives are active or present.

Given write accessing of parameters of a deactivated drive, the relevant data of the transmitted data block are discarded. Given read accessing, the CLC sends the value 0 for these parameters in the reaction telegram.

If a drive parameter is to be transmitted that is not in this preferred list, then it is possible to manually expand the list. Using parameters "data blocks - configurable S and P parameters, ID number" (C-0-0157) and "data blocks - configurable S and P parameters, data length" (C-0-0158) it is possible to expand up to 7 drive parameters.

The commissioning program SynTop offers a dialog for the settings with "CLC host communications". Use it to select additional S and P parameters.

List of the deposited CLC internal parameters see "data blocks - configurable S and P parameters, ID number" (C-0-0157) in SYNAX Parameter Description, DOK-SYNAX*-SY*-06VRS**-PA01-EN-P.

Data transmission with following telegrams (lists of variable length)

As data transmission with data blocks are not supported by following telegrams and parameters with fixed lengths are always transmitted in a telegram, the transmission of following telegrams is restrited to lists, i.e., parameters with variable lengths.

All lists mutually share the trait that the actual length (= programmed length, one word) and the maximum length, one word, are placed ahead of the actual list elements.

The length information supports the administration of the lists and offers both the CLC and the ARCNET partner the capability of allocating a sufficiently sized storage for the collection of all list data.

So as not to have to differentiate between short and long lists with respect to following telegrams, only the two long words are transmitted in the first telegram. As such it should be clear that each list transmission, even the short ones, necessitates at least one following telegram.

Note: The ARCNET partner can select the data length of the following telegram, depending only on the application. In other words, the maximum number of user data must not be exhausted in the data package. The CLC, however, in its telegram always transmits the maximum number of user data.

Announcing following telegrams

The CLC interprets the parameter number received on an ever higher level and thus cannot know at a telegram level and without additional information whether it can expect write access with following telegrams.

Since the data length in the telegram header only refers to a single telegram and not the entire length, and the value 0x8010 has been agreed to for a logial message number in the first telegram of a data transmission, it is necessary to announce following telegrams in the Indramat protocol expansion.

An ARCNET partner must know with each list access at an interpreter level that it is dealing with a lit so as to be able to handle the long words in the first data telegram. It is alo necessary with list transmissions in info access, of the Indramat protocol expansion (see section 1.3), to treat the bit for "transmission in progress/final transmission" in the following manner:

- write a list ==> info access = 0x001D, 'transmission in progress', as further data telegrams are still to be sent.
- read a list ==> info access = 0x001E, 'final transmission", as only data are requested.

Logial message number of following telegrams

The Indramat protocol expansion is dropped with following telegrams. Only user data are transmitted. As a result, the following telegrams are designed via the logial message number. The final following telegram always contains the value 0x1CFF, the first has the value 0x1C20, the others result from the incrementation of the previous number:

- logical message number = 0x1C20 ==> 1st following telegram
- logical message number = 0x1C21 ==> 2nd following telegram
- logical message number = 0x1C22 ==> 3rd following telegram
- ...
- ...
- logical message number = 0x1C28 ==> 9. following telegrams (penultimate telegram)
- logical message number = 0x1CFF ==> final following telegram

A jump in the value of the logical message number can therefore only occur between the penultimate and the ultimate .

An incorrect sequence of the following telegram or an unacceptable logical message number value are recognized by the CLC as an error with write access.

Examples of a list transmission

The following two examples depict the sequence of a list transmission by illustrating the individual ARCNET packages that result for the respective data transmission for the CLC and the ARCNET partner. The data are prepared in Intel format (see "Introduction", page 3-1).

Example 1: The ARCNET partner wants to load parameter C-0-0013 (a type list of 128 elements) into the CLC.

First, it must be marked that further telegrams are to follow. Then the actual and maximum lengths of the list are entered as user data in the first telegram. This results in five data words as permanent data length. The **bold values** are the important data for the first telegram for writing a list.

D 0	0A	(station number of the sender)
D 1	0B	(station number of the CLC)
D 2	EF	(data offset: 239)
D 3		
D 4		
...		
...		
D 239	7F	(protocol ID)
D 240	10	(logical message number LB)
D 241	80	(logical message number HB)
D 242	00	(command: 'TO')
D 243	05	(data type: Word-Array)
D 244	**05**	(**data length** in Word: LB)
D 245	**00**	(**data length** in Word: HB)
D 246	**1D**	(info access LB: **write access with following telegrams**)
D 247	00	(info access HB: not used)
D 248	00	(address byte: no axis)
D 249	02	(master ID byte: C parameter on the CLC)
D 250	0D	(parameter ID LB: C-0-0013)
D 251	00	(parameter ID HB: C-0-0013)
D 252	**00**	(**actual length** in bytes LB: 256 bytes = 128 Word ——>)
D 253	**01**	(**actual length** in bytes HB: **as agreed in list**)
D 254	**10**	**(maximum length** in bytes LB: 10000 Word ->)
D 255	**27**	(**maximum length** in bytes HB: **see SYNAX**)

Fig. 3-12: ARCNET table 5

The first following telegram with 123 data words can now be sent. It has logical message number 0x1C20. The **bold data** indicates the relevant data for the following telegrams.

D 0	0A	(station number of the sender)
D 1	0B	(station number of the CLC)
D 2	03	(data offset: 3)
D 3	7F	(protocol ID)
D 4	**20**	**(logical message number: LB)**
D 5	**1C**	**(logical message number: HB)**
D 6	00	(command: 'TO')
D 7	05	(data type: Word-Array)
D 8	7B	(data length in Word: LB)
D 9	00	(data length in Word: HB)
D 10	00	(1st list element LB)
D 11	00	(1st list element HB)
D 12	00	(2nd list element LB)
D 13	02	(2nd list element HB)
...		
...		
D 254	0D	(123rd list element LB)
D 255	00	(123rd list element HB)

Fig. 3-13: ARCNET table 6

The final following telegram with the last five data words looks like what is shown below (the **bold data** indicates the relevant data for the final following telegram):

D 0	0A	(station number of the sender)
D 1	0B	(station number of the CLC)
D 2	EF	(data offset: 239)
...		
...		
D 239	7F	(protocol ID)
D 240	**FF**	**(logical message number: LB)**
D 241	**1C**	**(logical message number: HB)**
D 242	00	(command: 'TO')
D 243	05	(data type: Word-Array)
D 244	05	(data length in Word: LB)
D 245	00	(data length in Word: HB)
D 246	00	(124th list element LB)
D 247	02	(124th list element HB)
...		
...		
D 254	0D	(128th list element LB)
D 255	00	(128th list element HB)

Fig. 3-14: ARCNET table 7

By means of the logical message number 0x1CFF, the CLC recognizes that it is the final data telegram and writes parameter C-0-0013 after accepting the data.

Example 2: The ARCNET partner wants to read parameter C-0-0013 (a type word list with 128 elements, for example).

The command telegram is not different from a read access without following telegram, with which response telegrams must be requested until the final following telegram has been entered.

D 0	0A	(station number of the sender)
D 1	0B	(station number der CLC)
D 2	F3	(data offset: 243)
D 3		
D 4		
...		
...		
D 243	7F	(protocol ID)
D 244	10	(logical message number: LB)
D 245	80	(logical message number: HB)
D 246	01	(command: 'FETCH')
D 247	05	(data type: Word-Array)
D 248	03	(data length in Word: LB)
D 249	00	(data length in Word: HB)
D 250	1E	(info access LB: read parameters)
D 251	00	(info access HB: not used)
D 252	00	(address byte: no axis)
D 253	02	(master ID byte: C parameter on the CLC)
D 254	0D	(parameter number LB: C-0-0013)
D 255	00	(parameter number HB: C-0-0013)

Fig. 3-15: ARCNET table 8

The CLC first sends the long words of the request list. The **bold values** mark the important data for the first response telegram when reading a list.

D 0	0B	(station number der CLC)
D 1	0A	(station number of the receiver)
D 2	EF	(data offset: 239)
D 3		
D 4		
...		
...		
D 239	7F	(protocol ID)
D 240	10	(logical message number: LB)
D 241	80	(logical message number: HB)
D 242	00	(command: 'TO')
D 243	05	(data type: Word-Array)
D 244	**05**	(**data length** in Word: LB)
D 245	**00**	(**data length** in Word: HB)
D 246	**1E**	(info access LB: **read parameters as requested**
D 247	00	(info access HB: not used)
D 248	00	(address byte: no axis)
D 249	02	(master ID byte: C parameter on the CLC)
D 250	0D	(parameter number LB: C-0-0013)
D 251	00	(parameter number HB: C-0-0013)
D 252	**00**	(**actual length** in bytes LB: 256 bytes = 128 Word ——>)
D 253	**01**	(**actual length** in bytes HB: **as agreed to in the list**)
D 254	**10**	**(maximum length** in bytes LB: 10000 Word ->)
D 255	**27**	(**maximum length** in bytes HB: **see SYNAX**)

Fig. 3-16: ARCNET table 9

The ARCNET partner can now request the first following telegram with 123 data.

D 0	0A	(station number of the sender)
D 1	0B	(station number der CLC)
D 2	F3	(data offset: 243)
D 3		
D 4		
...		
...		
D 243	7F	(protocol ID)
D 244	10	(logical message number: LB)
D 245	80	(logical message number: HB)
D 246	01	(command: 'FETCH')
D 247	05	(data type: Word-Array)
D 248	03	(data length in Word: LB)
D 249	00	(data length in Word: HB)
D 250	1E	(info access LB: read parameters)
D 251	00	(info access HB: not used)
D 252	00	(address byte: no axis)
D 253	02	(master ID byte: C parameters on the CLC)
D 254	0D	(parameter number LB: C-0-0013)
D 255	00	(parameter number HB: C-0-0013)

Fig. 3-17: ARCNET table 10

The CLC sends the first following telegram with 123 data words with the logical message number 0x1C20. The **bold values** indicate relevant data for the following telegrams.

D 0	0B	(station number der CLC)
D 1	0A	(station number of the receiver)
D 2	03	(data offset: 3)
D 3	7F	(protocol ID)
D 4	**20**	**(logical message number: LB)**
D 5	**1C**	**(logical message number: HB)**
D 6	00	(command: 'TO')
D 7	05	(data type: Word-Array)
D 8	7B	(data length in Word: LB)
D 9	00	(data length in Word: HB)
D 10	00	(1st list element LB)
D 11	00	(1st list element HB)
D 12	00	(2nd list element LB)
D 13	02	(2nd list element HB)
...		
...		
D 254	0D	(123rd list element LB)
D 255	00	(123rd list element HB)

Fig. 3-18: ARCNET table 11

Finally, the ARCNET partner can request the final following telegram with the last 5 data words.

D 0	0A	(station number of the sender)
D 1	0B	(station number der CLC)
D 2	F3	(data offset: 243)
D 3		
D 4		
...		
...		
D 243	7F	(protocol ID)
D 244	10	(logical message number: LB)
D 245	80	(logical message number: HB)
D 246	01	(command: 'FETCH')
D 247	05	(data type: Word-Array)
D 248	03	(data length in Word: LB)
D 249	00	(data length in Word: HB)
D 250	1E	(info access LB: read parameters)
D 251	00	(info access HB: not used)
D 252	00	(address byte: no axis)
D 253	02	(master ID byte: C parameters on the CLC)
D 254	0D	(parameter number LB: C-0-0013)
D 255	00	(parameter number HB: C-0-0013)

Fig. 3-19: ARCNET table 12

The CLC sends the following telegram with the last 5 data words (the **bold values** indicate relevant data for the final following telegram:

D 0	**0B**	**(station number der CLC)**
D 1	0A	(station number of the receiver)
D 2	EF	(data offset: 239)
...		
...		
D 239	7F	(protocol ID)
D 240	**FF**	**(logical message number: LB)**
D 241	**1C**	**(logical message number: HB)**
D 242	00	(command: 'TO')
D 243	05	(data type: Word-Array)
D 244	05	(data length in Word: LB)
D 245	00	(data length in Word: HB)
D 246	00	(124thist element LB)
D 247	02	(124th list element HB)
...		
...		
D 254	0D	(128th list element LB)
D 255	00	(128th list element HB)

Fig. 3-20: ARCNET table 13

By means of the logial message number 0x1CFF the ARCNET partner recognizes that it has received the entire list with this telegram.

Data structure as a long package

A long telegram is sent from one ARCNET controller to the other in a long package in the ARCNET configuration supported by SYNAX. A long package always has 512 bytes and contains the required ARCNET information in addition to the telegram data.

SID (Source ID) ARCNET address of the participant sending

DID (Destination ID) ARCNET address of the participant receiving

Count Data offset in long package as of where telegram data start.

An ARCNET package is always organized in such a way that the ARCNET specific section is located at the beginning of the package, the telegram data end at precisely the 512th byte of the package. The intermediate range is invalid. The data offset "count" references that byte of a long package where the data once again are valid. The data structure of a telegram with length n looks like this:

D0	SID (ARCNET adresse of the sender)
D1	DID (ARCNET adresse of the receiver)
D2	**0** (ID for long packages)
D3	Count = 512-n (long package) = data offset in ARCNET-RAM, n>256.
D4	
...	
D Count	protocol ID: always **7Fh** (always uneven address)
D Count+1	logical message number LB: 10h
D Count+2	logical message number HB: 80h
D Count+3	command byte
D Count+4	data type byte: always **5h** (Word-Array)
D Count+5	data length LB
D Count+6	data length HB: always **0h**
D Count+7	info access LB
D Count+8	info access HB: always **0h**
D Count+9	address byte (drives, data blocks)
D Count+10	master ID byte
D Count+11	parameter ID LB
D Count+12	parameter ID HB
D Count+13	1. data word LB
D Count+14	1. data word HB
...	
D 510	mth data word LB
D 511	mth data word HB (end short package)

Fig. 3-21: ARCNET table 1

The fixed values of the data exchange protocol are highlighted. The following applies to the values which can be changed:

- logical NN LB: (0x20 .. 0xFF in folowing telegrams, 0x10 otherwise)
- logical NN HB: (0x1C in following telegrams, 0x80 otherwise)
- command byte: 0 => TO telegram, 1 => FETCH telegram
- data length LB: length in [word] as of address byte
- info access LB: 1Fh => data write,
1Eh => data read;
other possible values see section 1.3
- address byte 0 => with C parameter,
> 40 => with data blocks (as DB number),
otherwise => drive address with A, S or P parameters
- master ID: 2 => C parameters,
1 => A parameters,
0 => others
- parameter ID: Ident number of the parameters, with P parameters, add value 8000h
- data words: D 509 is fill byte at telgram length n=254
D 510 is fill byte at telegram length n=254, 255
D511 is fill byte at telegram length n=254, 255, 256

Example: The transmission of C-0-0013 (see example 1 for the transmission of a list transmission with short data packages) can be shortened to two telegrams.

The ARCNET partner wants to load parameter C-0-0013 (a list of the type 'Word' with, e.g., 128 elements) into the CLC.

It is necessary to first mark that other telegrams are following. Then, in the first telegram, only the actual lengths and the maximum lengths of the list of user data are entered. The results are five data words as a fixed data length. The **bold values** are the important data for the first telegram when writing a list.

This telegram must always be sent in a short data package.

D0	0A	(station number of the section computer)
D1	0B	(station number of the CLC)
D2	EF	(data offset: 241)
D3		
D4		
...		
D239	7F	(protocol ID)
D240	10	(logical message number LB)
D241	80	(logical message number HB)
D242	00	(command:"TO")
D243	05	(data type: word-array)
D244	**05**	(**data length** in word: LB)
D245	**00**	(**data length** in word HB)
D246	**1D**	(info access LB: **write access with following telegrams**)

D247	00	(info access HB: not used)
D248	00	(address byte: no axis)
D249	01	(master ID byte: C parameter on the CLC)
D250	3C	(parameter ID LB: C-0-0013)
D251	00	(parameter ID HB: C-0-0013)
D252	**00**	(**actual length** in byte LB: 256 byte = 128 word ——>)
D253	**01**	(**actual length** in byte HB: **as agreed in the list**)
D254	**10**	(**maximum length** in byte LB: 10000 word ->)
D255	**27**	(**maximum length** in byte HB: **see SYNAX**)

Fig. 3-22: ARCNET Tabelle

The following telegram with the 128 data words can now be sent in a long data package. It has the logical message number 0x1CFF. The **bold data** represent the relevant data for the following telegrams.

D 0	0A	(station number of the receiver)
D 1	0B	(station numberof the CLC)
D 2	EF	(data offset: 249)
...		
...		
D 249	7F	(protocol ID)
D 250	**FF**	**(logical message number: LB)**
D 251	**1C**	**(logical message number: HB)**
D 252	00	(command: 'TO')
D 253	05	(data type: word-Array)
D 254	05	(data length in word: LB)
D 255	00	(data length in word: HB)
D 256	00	(1. list element LB)
D 257	02	(1. list element HB)
...		
...		
D 510	0D	(128. list element LB)
D 511	00	(128. list element HB)

Fig. 3-23: ARCNET Tabelle 7

Note: Telegrams with a length of less than 253 bytes must always be sent in a short data package. Telegrams with a length of 254-256 bates can be sent in a long data package with 3-1 filler bytes at the end of the telegram.

Hardware

The ARCNET coupling with the CLC uses the DAQ02 daughter board. It has the following important components.

COM 20020

is the ARCNET controller which proesses the basic ARCNET protocol (ANSI 878.1).

HYC 9088/R

is the HIT module (High Impedance Transceiver). It realizes the eletrical bus connection. The DAQ02 can thus be placed anywhere in the ARCNET bus.

BNC coaxial bushing

This establishes the connection for the transmission medium. The connection to the bus neighbors is established via the T-BNC adapter by means of the coaxial RG-62.

A final resistance (93 Ω) must be mounted in the ARCNET bus or in the case of a Wye-system topology.

Rotary switch (0-F) two-fold (on printed circuit board)

Supports fixing of the ARCNET participant number.

Topology	Bus
transmission medium	coaxial cable RG-62(/U) 93 Ω
bus connection	BNC (room for T-adapter)
bus interface	HIT (High Impedance Tranceiver)
participant number	1 ... 255 configurable

Fig. 3-24: Prerequisites for SYNAX hardware

4 Fieldbus interfaces

4.1 Introduction

This section describes the general part of the fieldbus interfaces Profibus, Interbus and DeviceNet of Indramat CLC-D control card.

These interfaces can be used

- to transmit binary signals as a substitute for 24 volt I/Os,
- for the cyclical transmission of command and actual values while in operation, e.g., velocity command value / actual value of the virtual master axis
- and non-cyclical transmission of parameters and phase progressions, e.g., a product-dependent reparametrization or read out of the diagnosis.

Note: Due to the internal running time of communication using a fieldbus a cyclical position control via the fieldbus is not possible.

The fieldbus is connected via a plug-in card that is permanently linked to the CLC. The firmware of the plug-in card works like a fieldbus slave and internally exchanges data with the CLC via the dual port ram.

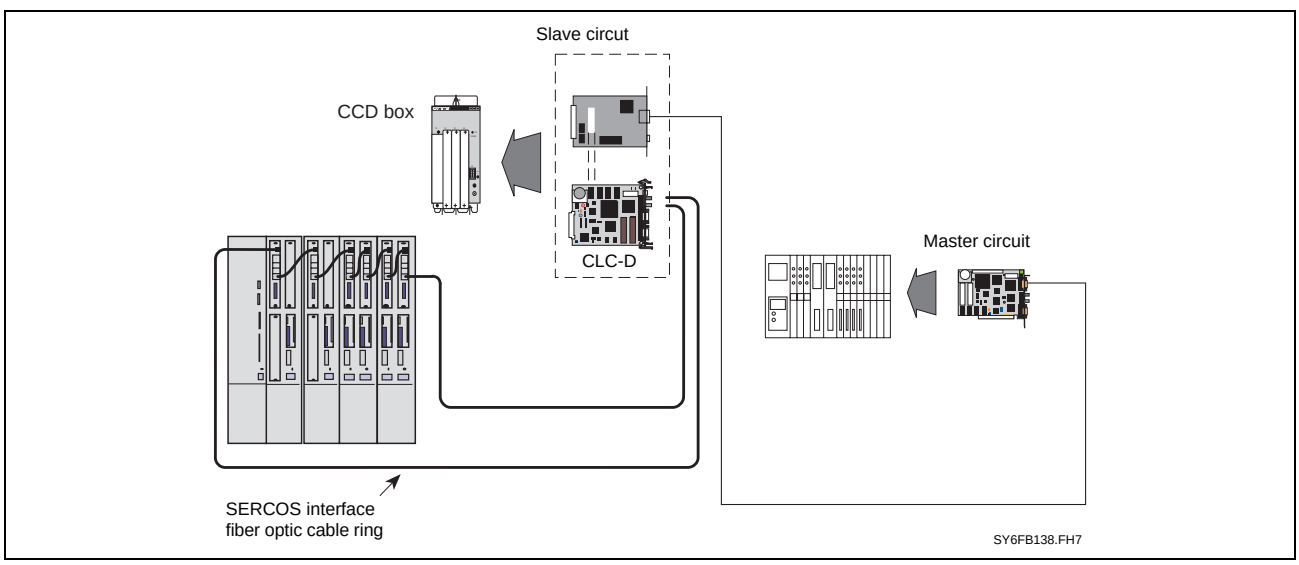


Fig. 4-1: Topological structure of master slave communication

Functional module To make it easier to connect SYNAX to a PLC via a fieldbus Indramat provides functional modules, e.g., for the Simatic-S7. Please contact the applications group whether there are examples for the PLC and the fieldbus which you use.

4.2 Data objects

Data is exchanged via the fieldbus via data objects.

For cyclical transmission (real time channel) there are

- data objects of 2 byte size for I/Os and
- data objects as freely configurable "container“ objects for parameters of 2 or 4 byte size (parameter objects).

The master can directly access these in real time.

In non-cyclical transmission (communication channel) there are four data exchange objects. These can be used to R/W any parameter, (including list parameters) and the CLC mode which is embedded in a special protocol. These four objects are byte arrays of various lengths (see "Fieldbus objects for data exchange", page 4-19).

Various transmission channels are available for transferring data depending on the fieldbus. These will be described in the following texts.

4.3 Transmission channels

Process data channel

The process data channel includes all words cyclically exchanged between the fieldbus master and the CLC and in real time. It is up to 16 words long with the Profibus and the DeviceNet and 15 with the Interbus. The configuration is on the fieldbus card in objects 6000 and 6001.

In the case of DeviceNet and Interbus the process data channel and the real time channel are identical. The process data channel of the Profibus is made up of a real time channel and an optional parameter channel.

Real time channel

The real time channel is a part of the process data channel. In the real time channel the I/Os and the cyclical command and actual values are transmitted. The multiplex channel is optionally at the back. All data in the real time channel are processed by the CLC in operating mode only.

At start-up, the I/O objects to be transmitted and the container objects for the parameters are fixed once. In the second step, this input and output data is parametrized via SynTop (C-0-0127, C-0-0128). The parameters that are to be cyclically transmitted must be entered in the parameter objects used ("configuration list data block xy“) (see "Fieldbus objects for data exchange", page 4-19).

Multiplex channel

After the objects for the I/O have been configured in the real time channel, a reduced number of data words are available for the command and actual values. If the number needed exceeds the numbers available, then multiplexing becomes necessary. In the last word of the real time channel, multiplex control and status words are configured.

The contents (= parameter values) of the objects with the number of base objects plux index are transmitted in both data directions when in operation mode, but dependent on an index specified by the master and starting with the base objects.

Communication channel

The communication channel is for non-cylical transmission.

Direct data accessing to the contents of the container objects and the data exchange objects is not possible. Direct accessing to the other fieldbus objects is possible.

Using the four data exchange objects it is possible to R/W indirectly

- any A,C,S and P parameter (includes list parameters) and
- of the CLC mode

embedded in a special protocol (Indramat SIS protocol). (see "Fieldbus objects for data exchange", page 4-19).

The communication channel in Interbus corresponds to the PCP channel, in Profibus to the FMS channel and with DeviceNet the Explicit Message.

Parameter channel

The parameter channel is only available with Profibus-DP and replaces Profibus FMS. The first six words in the process data channel are reserved for this purpose.

In many applications, especially with PLC systems, only the Profibus DP protocol is used. This means it is no longer possible to parametrize via FMS.

In order to transmit a single parameter embedded in Indramat's SIS protocol in a PLC cycle, the abbreviated format 1 was additionally implemented. (See "Short format 1 for parameters" in section 5.6).

Note: The PCP channel in the Interbus is frequently also called the parameter channel. To distinguish the parameter channel in Profibus from the PCP channel in Interbus in this document, the PCP channel is not called the parameter channel but rather the communication channel.

4.4 Transmission time in the real time channel

The transmission of an I/O signal or a parameter in the real time channel, e.g., from PLC program to the point of effectiveness of the CLC, can be broken down into the following sections:

- The PLC puts the data in each PLC cycle into the dual port RAM between CPU and fieldbus master.
- The fieldbus master puts the data on the bus.
- The fieldbus interface card of SYNAX takes the data and puts it on the dual port RAM between interface card and CLC.
- The CLC copies the data out of the dual port RAM into a data buffer.
- I/O signals are processed in the I/O logic which is activated every 8 ms. Parameter handlers, activated every 20 ms, change parameters. If the handler is active, then all write accesses to the parameters that have changed since the previous activation will be conducted as well as precisely one read access to a parameter of the process input data.

Note: The data handler needs ten SERCOS cycles for a write access to an S or P parameter (single parameters), and 10 SERCOS cycles for a read access to an S or P parameter if this parameter has not been configured in the drive telegram (S-0-0016). A pre-requisite is that the service channel of SERCOS is not occupied!

- The changed parameter value becomes effective once the value is read by the relevant CLC function the next time.

The transmission section between fieldbus circuit and CLC is displayed in Fig. 4-2: Temporal behavior when write accessing via real time channel.

This demonstrates that transmission time depends on

- the PLC cycle time,
- the fieldbus cycle time,
- the SERCOS cycle time,
- the number of the simultaneously changed parameters,
- the parameter type to be transmitted and
- the CLC load.

A general rule for a conservative projection is:

Time critical I/O signals with system reaction times < 100ms should not be transmitted via the fieldbus but instead, for example, via a DEA28.

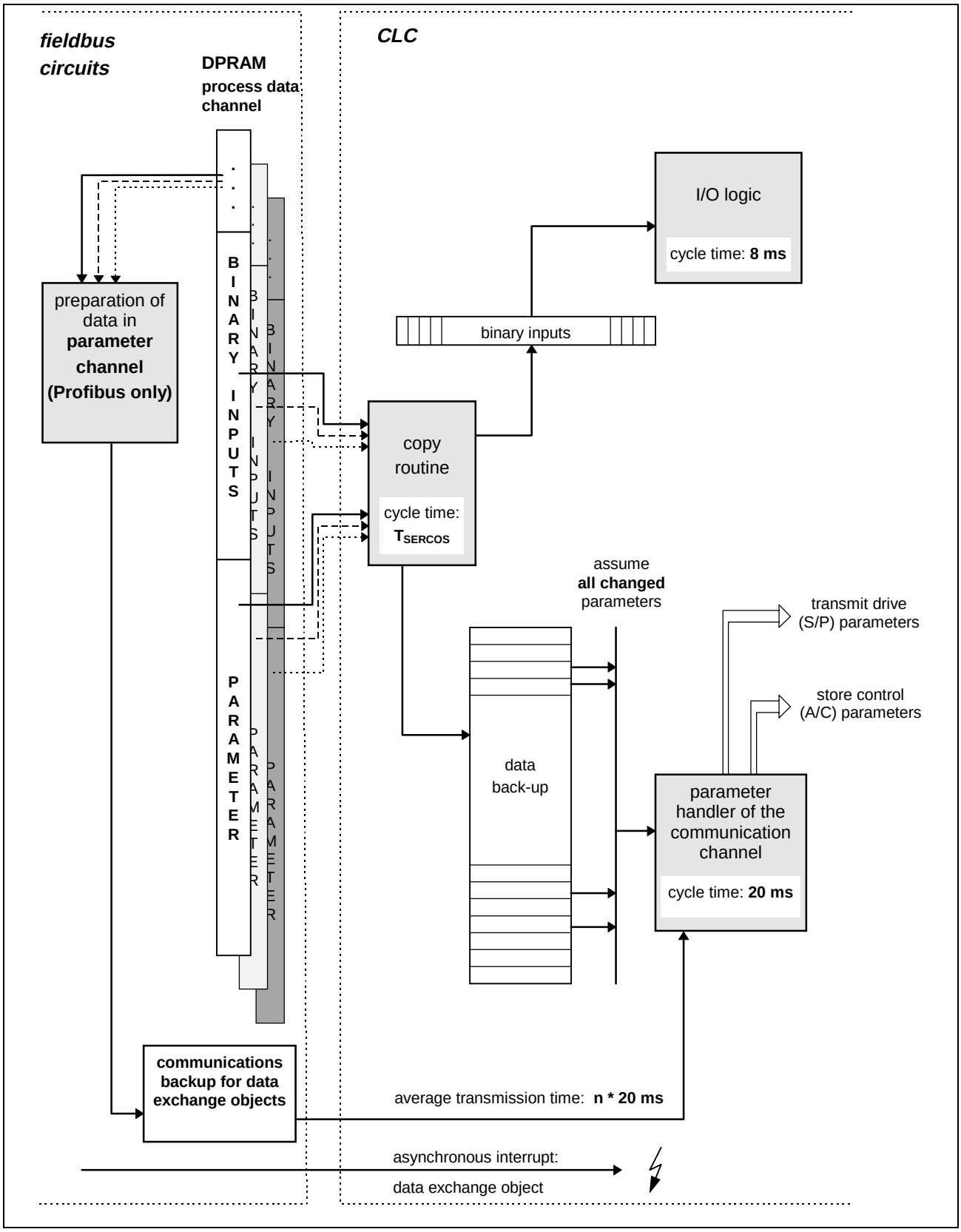


Fig. 4-2: Temporal behavior when write accessing via real time channel

4.5 Monitoring fieldbus transmission

Data safety

Transmitting data via the fieldbus is safe. If data are transmitted from master to the slaves or vice versa, then these are subjected to extensive checks. Data detected as faulty during transmission are discarded and thus ineffective. With Interbus and Profibus the hamming distance = 4, in DeviceNet = 6, i.e., in Interbus and Profibus three bit errors are detected, with DeviceNet 5 bit errors per message.

Behavior with bus failure

The fieldbus can fail. Failure can be caused by a cable break or slaves crashing. In this case, the once entered data is retained until the new data is received.

Watchdog function The fieldbus module has a bus monitor equipped with a watchdog timer and is thus able to immediately respond to any bus failure.

Error reaction The fieldbus module makes it possible to set two error reactions for the process data channel which can meet varying demands.

The behavior with bus failure is parameterized differently in each fieldbus. Read the relevant sections on this.

4.6 Configuration of the real time channel

If a fieldbus interface has been parametrized on the CLC in the "host communication - control word" (C-0-0033) then it is fixed in parameter "fieldbus - control word" (C-0-0129) whether the fieldbus configuration uses the PLC or the CLC. Configuration in actuality takes place with the SynTop via the CLC. Configuration via the PLC is no longer used.

Note: Bus configurations via the CLC mean that the bus master must not configure.

The number of parameters configured by SYNAX is much greater than the number of objects fixed for the fieldbus for transmission of parameters. To avoid limiting yourself with pre-selected parameters in the case of a SYNAX application with 40 drives, the fieldbus interface of the CLC can be freely configured.

Parameters for the fieldbus interface

The parameters shown in Fig. 4-3 are to be used for the fieldbus interface and for transmission in the real time channel. The parameters are set either with bus configuration via the CLC - all via SynTop - or with bus configuration via the PLC - partially via the fieldbus objects.

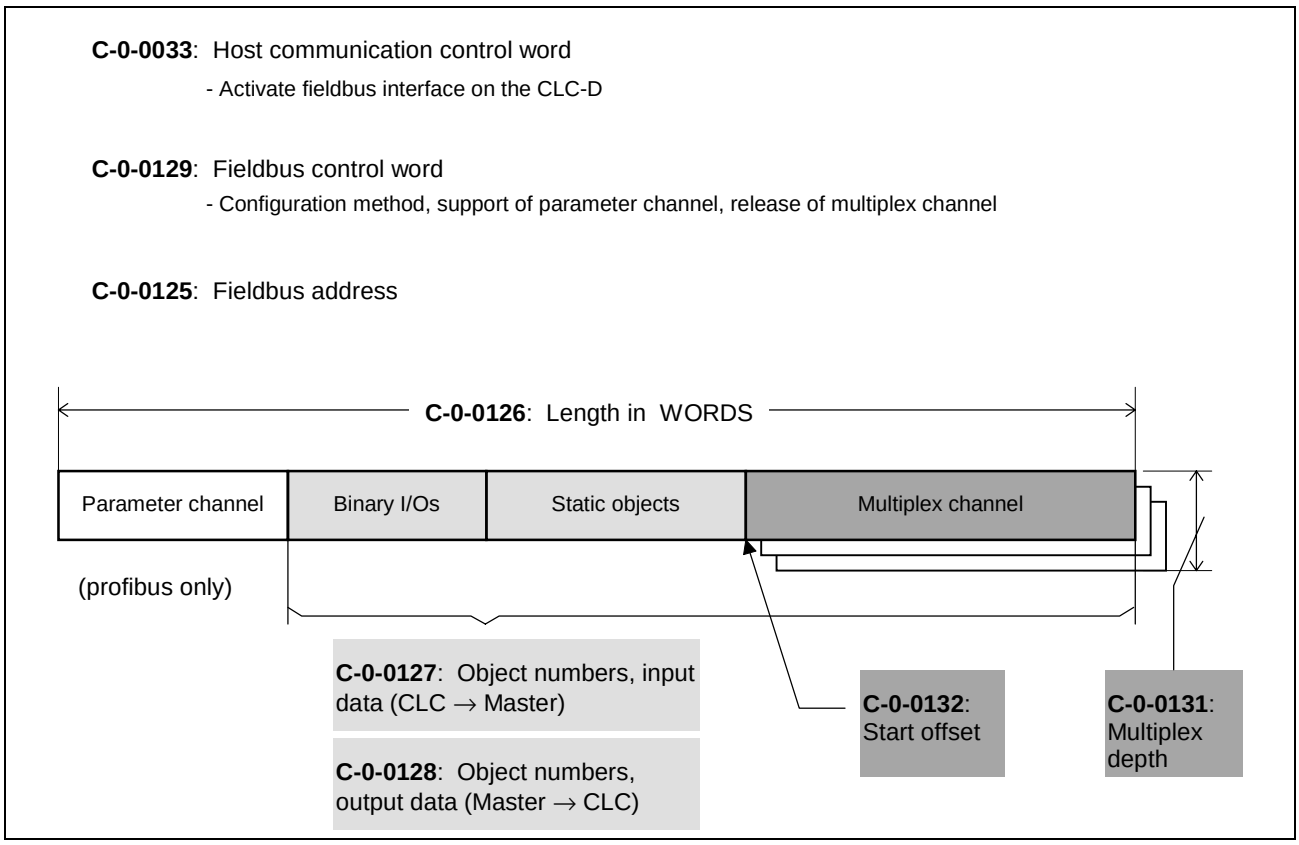

C-0-0033: Host communication control word
- Activate fieldbus interface on the CLC-D
C-0-0129: Fieldbus control word
- Configuration method, support of parameter channel, release of multiplex channel
C-0-0125: Fieldbus address
C-0-0126: Length in WORDS
Parameter channel
Binary I/Os
Static objects
Multiplex channel
(profibus only)
C-0-0127: Object numbers, input data (CLC → Master)
C-0-0128: Object numbers, output data (Master → CLC)
C-0-0132: Start offset
C-0-0131: Multiplex depth

Fig. 4-3: Parameters for the fieldbus interface and the configuration of the real time channel

Note: The parameters are individually explained in the SYNAX Parameter Description.

Bus configuration via the CLC

The slave is configured via SynTop fieldbus dialogs. The master does not have to undertake any other configurations.

The configuration can be broken down into seven steps:

Step 1: Determining requirements

In the first step, determine the number of I/O signals and the parameters (command/actual values) to be cyclically transmitted when the machine is in operation. Using the attribute of the parameter determine whether the value has two or four bytes. This data is then later transmitted in the real time channel. List parameters cannot be transmitted in the real time channel.

Define all parameters via the fieldbus that might need to be R/W or with a product change. This data is transmitted - if possible - in the communication channel or parameter channel. Parameters write protected in operating mode can only be altered when in the communication or parameter channel.

		SPS → CLC	CLC → SPS
inputs/outputs		**3 words for binary inputs**	**3 words for binary outputs**
5 * 5 + 10 = 35 inputs/outputs			
command value during production		**4 4byte objects**	
VM - speed command (C-0-0006)	= 4 bytes		
setup position (A-0-0056)	= 4 bytes		
gear fine adjustment (A-0-0060)	= 2 bytes	**1 2byte objects**	
monitoring and diagnosing			
VM - actual speed value (C-0-0067)	= 4 bytes		**5 4 byte objects**
add. pos. comm. value (A-0-0004)	= 4 bytes		
diagnostics text (C-0-0047)	= text string		**comm. channel/ parameter channel**
product specific data			
electronic gear (S-0-0236/S-0-0237)	=parametr. mode!	**comm. channel/ parameter channel**	
lead drive polarity (P-0-0108)	=parametr. mode!		

Fig. 4-4: Example of step 1: "determining requirements"

Step 2: Generating a concept

Put the parameters in the real time channel on the available data words. Start with the I/O signals.

If it is required to transmit more words than there is space in the real time channel, you have to decide which parameter you do not need to transmit each fieldbus cycle. These can be multiplexed in the back part (e.g., Fig. 4-5, word 14, 15).

Reserve in this case the last word for the multiplex control/status word (Profibus/DeviceNet: word 16, Interbus: word 15).

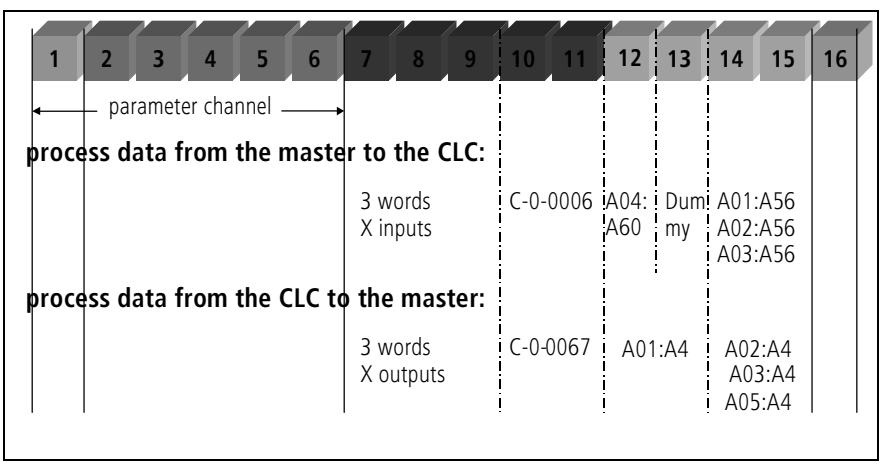


Fig. 4-5: Example (Profibus) of step 2 "generating a concept", the first six word parameter channel only with Profibus

Step 3: General settings

Activate the fieldbus via the SynTop dialog "CLC host communication basic settings“ and set the parameters in the SynTop dialog "fieldbus settings“.

Step 4: Configuring the assignment of the real time channel

Based on the concept of step 2 assign objects to the real time channel for the I/O and container objects for 2 and 4 byte parameters. The input lists in the SynTop dialog "Fieldbus process data channel“ are stored on the CLC in parameters C-0-0127, C-0-0128. These correspond to fieldbus objects 6000, 6001.

Object no.	Designation
5F80	outputs group 1
5F81	outputs group 2
5F82	outputs group 3
5E80	DB101, element 1, (container object for C-0-0067)
0000	fill object for 32 bit object
5E90	DB102, element 1, (container object for drive 1: A-0-0004)
0000	fill object for 32 bit object
5EA0	DB103, element 1, (base object for multiplexed A-0-0004)
0000	fill object for 32 bit object
5FFD	mulitplex status word

Fig. 4-6: Example (Profibus) for step 4 "configuration of assignment of real time channel“, data direction from CLC to master. (Six word parameter channel only with Profibus.)

Object no.	Designation
5FA0	inputs group 1
5FA1	inputs group 2
5FA2	inputs group 3
5ED0	DB106, element 1, (container object for C-0-0006)
0000	fill object for 32 bit object
5F20	DB111, element 1, (container object for drive 4: A-0-0060)
5FF1	Dummy objects for unused word als Platzhalter
5EE0	DB107, element 1, (base object for multiplexed A-0-0056)
0000	fill object for 32 bit object
5FFC	multiplex control word

Fig. 4-7: Example (Profibus) for step 4 "configuration of assignment of real time channel“, data direction from master to CLC. (Six word parameter channel only with Profibus)

All fieldbus objects for data exchange are listed in section 4.9.

Step 5: Parametrizing the contents of the container objects

After assigning the still empty container objects to their position in the real time channel, these are filled in the next step with contents, i.e., the parameter to be transported is now entered.

Each container object equals an element of a data block. To transmit a parameter in a container object it is necessary to enter it into the corresponding element of the data block.

Use the SynTop dialog "data block master -> CLC (output data)“ and "data block master -> CLC (output data)“.

Note: The term "data block" used in association with fieldbuses has nothing to do with the data block of a PLC.

A total of 16 data blocks can be configured on the CLC. The configuration uses parameters "configuration list data block 101" (C-0-0058) through "configuration list data block 108" (C-0-0065) and parameters "configuration list data block 109" (C-0-0078) through "configuration list data block 116" (C-0-0085). These are allocated to blocks DB 101 to 116 as follows:

SYNAX parameters	DB	object no.
C-0-0058 element 1 - 16	DB 101 element 1 - 16	5E80-5E8F
C-0-0059 element 1 - 16	DB 102 element 1 - 16	. 5E90-5E9F
...	...	...
C-0-0065 element 1 - 16	DB 108 element 1 - 16	5EF0-5EFF
C-0-0078 element 1 - 16	DB 109 element 1 - 16	5F00-5F0F
C-0-0079 element 1 - 16	DB 110 element 1 - 16	. 5F10-5F1F
...	...	...
C-0-0085 element 1 - 16	DB 116 element 1 - 16	. 5F70-5F7F

Fig. 4-8: Allocating data blocks

For 4 byte parameters use the container objects for 4 byte parameters (DB 101-110 = C-0-0058 - C-0-0065, C-0-0078, C-0-0079), for 2 bytes use the 2 bytes (DB 111-116 = C-0-0080 - C-0-0085).

The configuration list has a variable length and a data width of 4 bytes. The parameter to be transported is entered according to the following syntax in each element of a list that is used (SYNAX format):

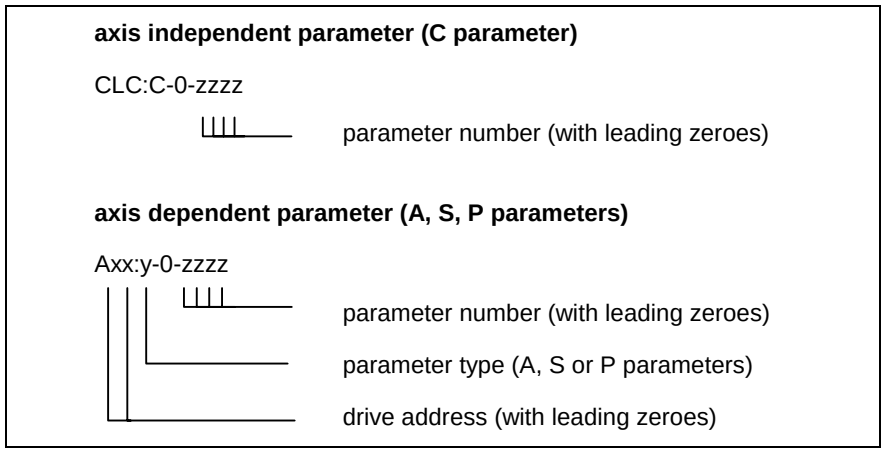

axis independent parameter (C parameter)
CLC:C-0-zzzz
parameter number (with leading zeroes)
axis dependent parameter (A, S, P parameters)
Axx:y-0-zzzz
parameter number (with leading zeroes)
parameter type (A, S or P parameters)
drive address (with leading zeroes)

Fig. 4-9: Parameter number in SYNAX format

Control parameters

The process variables are displayed in the A and C parameters on the CLC. These are generally exchanged in real time between PLC and CLC. These variables can be configured as static objects or multiplex objects in the real time channel.

Drive parameters

The S and P parameters are transmitted via the SERCOS fiber optic ring between the CLC control and the individual drives. Access times depend on whether a parameter is exchanged as "real time data" between CLC and drive or via a slower "service data channel". So as not to block the communication tasks on the CLC and the access via SynTop, the PLC should only read S and P parameters in the real time channel that have been cyclically configured via SERCOS (see S-0-0016). S and P parameters should generally not be written.

Note: When transmitting drive parameters, i.e., S and P parameters, do use the non-cyclical channel (communication / parameter channel).

Example:

In this example, the set up position 0 (A-0-0056) of axes 1 through 3 is to be transmitted in words 14 and 15 from the PLC to the CLC. To do so, the base object 5EE0 (= DB107, element 1 = C-0-0064) in step 4 has been parametrized for word 14, and for word 15 the fill object for the 32 bit object in the real time channel.

The parameters are entered into the relevant objects Fig. 4-10.

Object no.	Parameter	Designation
5EE0	C-0-0064 element 1	A01:A-0-0004 drive 1, position command offset
5EE1	C-0-0064 element 2	A02:A-0-0004 drive 1, position command offset
5EE2	C-0-0064 element 3	A03:A-0-0004 drive 1, position command offset

Fig. 4-10: Example for the assignment of data blocks to elements

Step 6: Activating the fieldbus

Switch the control voltage on and off to activate the fieldbus group.

Bus configuration via PLC

Note: Bus configuration via the PLC is not supported by the DeviceNet slave interface DCF01.
When using fieldbus interfaces Interbus and Profibus the configuration via the PLC is no longer done in reality.

The fieldbus master can configure the fieldbus via the fieldbus objects 6000, 6001 and 5FFE. The parameters C-0-0125 - C-0-0129 and C-0-0131 and C-0-0132 are used for diagnostics.

In contrast to bus configuration via CLC, step 4 takes place via the master. All other steps are identical, i.e., the contents of the parameter objects in the real time channel are parametrized by the CLC.

The above referenced fieldbus objects cannot be write accessed via the process data channel. Only a fieldbus master that supports the communication channel can configure the fieldbus.

The following describes how to handle object 6000. This also applies to object 6001.

Process input data (data from CLC to PLC)

In object 6000 the structure and thus the number of words and their assignments with objects (indices) for the process input data are displayed.

The user can read out the existing structure using "read" and "write" of the communication channel and by inputting a new structure determine a new configuration of the process input data.

The length of object 6000 is fixed by the maximum number of words at the fieldbus without taking the communication channels into consideration.

In the first byte of 6000 the bus length is entered in bytes (hex).

The entries for each byte on the bus follows in rising order. For each byte, the object number (index) is displayed as a two byte data entry and an additional byte is left open for a subindex. The subindex is always zero for the fieldbus modules.

An object is made up of several bytes (standard for fieldbus groups is the word structure, i.e., always at least two bytes). Thus the entry for the object number can only be made for the first byte. The allocation of the object number for the remaining bytes must be set in the subindex (zero).

Byte no.	Value	Definition
1	0x08	Bus length of the process data chan.in bytes
2	0x5F	1st byte on bus; **5F**91
3	0x91	1st byte on bus; 5F**91**
4	0x00	Subindex of object 5F91 (always 00)
5	0x00	2nd byte on bus; still object 5F91 (word)
6	0x00	2nd byte on bus; still object 5F91 (word)
7	0x00	Subindex of object 5F91 (always 00)
8	0x5F	3rd byte on bus; **5F**92
9	0x92	3rd byte on bus; 5F**92**
10	0x00	Subindex of object 5F92 (always 00)
11	0x00	4th byte on bus; still object 5F92 (word)
12	0x00	4th byte on bus; still object 5F92 (word)
13	0x00	Subindex of object 5F92 (always 00)
14	0x5F	5th bytes on bus; **5F**10
15	0x10	5th byte on bus; 5F**10**
16	0x00	Subindex of object 5F10 (always 00)
17	0x00	6th byte on bus; still object 5F10 (D-Word)
18	0x00	6th byte on bus; still object 5F10 (D-Word)
19	0x00	Subindex of object 5F10 (always 00)
20	0x00	7th byte on bus; still object 5F10 (D-Word)
21	0x00	7th byte on bus; still object 5F10 (D-Word)
22	0x00	Subindex of object 5F10 (always 00)
23	0x00	8th byte on bus; still object 5F10 (D-Word)
24	0x00	8th byte on bus; still object 5F10 (D-Word)
25	0x00	Subindex of object 5F10 (always 00)

Fig. 4-11: Example: Default data contents of object 6000

Note on Interbus: Object 6000 has a length of 187 bytes (for a maximum of 31 PD words in the bus). Read accessing by the bus master means that the complete object will be transmitted by the slave. Write accessing means that the master must send the DBS cards the actual length of the relevant number of bytes.

Note on Profibus: Object 6000 has a length of 97 bytes (for a maximum of 166 DP words in the bus). Read accesing by bus master means the slave transmit the entire object. Write accessing by the bus master means that the DPF cards expects the complete list.

Configuration with values from EEPROM

If the fieldbus master does not conduct a bus configuration after power up, then the configuration last saved in the EEPROM on the circuit module becomes effective. The following is the default configuration in the EEPROM at delivery.

	Word 1:	Word 2:	Word 3:	Word 4:
OUT:	5FB1	5FB2	5FB3	5FF1
IN:	5F91	5F92	5F10(H)	5F10(L)

Fig. 4-12: Default assignment of the process data channel with Profibus

For a non-resident saving of a new configuration use object 5E7D. Note however that the hardware of the fieldbus module cannot be simply replaced in the event that this should become necessary.

4.7 Multiplex channel

If the required number of data words in the real time channel should exceed the available number, then multiplexing becomes necessary. In this case, the real time channel is made up of static objects (not multiplexed) and the base objects.

The multiplexed channel is always at the end of the real time channel. In extreme cases, there are no static objects because all data has to be multiplexed.

A configuration of the real time channel with multiplex channel was already exemplified on page 4-8. The configuration and the functional principle of the multiplex channel are explained.

Multiplex control word / status word

The end of the multiplex channel is the control word 5FFC or the status word 5FFD.

This means that if the multiplex channel is used

- the multiplex control word 5FFC in the list of the data from master to CLC (process output data, C-0-0128) and
- the multiplex status word 5FFD in the list of the data from the CLC to the master (process input data, C-0-0127)

must be configured as the final list entry.

In operation, the master specifies the current multiplex index in the control word. With another bit, the master can signal that the data is valid and the CLC can accept the data of the selected multiplex level. The CLC follows the specified index (as long as it is smaller or equal to the multiplex depth) and acknowledges the index in the status word. By means of another bit, the CLC can signal that the data is valid and the master can accept the data of the acknowledged multiplex level.

The multiplex sequence and the bits used in the multiplex control and status words are different depending on the fieldbus. Read the relevant bus-specifications for details.

Base objects

Only the objects of the multiplex range 0 (base objects) are configured in the real time channel. Permissible base objects are all elements of the data blocks. During operation and depending on the index specified by the master and based on the base objects, the contents (= parameter values) of the object are transmitted with the number of the base object plus index. This is done in both directions.

The index in the control word is thus simply added to the base object thus indexing the object.

Example: base object 5F10 and index 6 => indexed object 5F16

Example: In the real time channel

object 5F10 = DB110, element 1 = C-0-0079, element 1

is configured as input object. This object is used as base object for the multiplex channel. Sixteen multiplex levels (also indices 0 to 15) are used. By dynamically specifying one of the 16 indices, the master can read out one of the 16 objects 5F10 to 5F1F. No order need be maintained in this case. The 16 objects can be actual positions of 16 axes, for example.

The allocation of the objects within the multiplex channel is listed below:

Object	Allocation in the data blocks
5F1F	Index 15
5F1E	Index 14
5F1D	Index 13
5F1C	Index 12
5F1B	Index 11
5F1A	Index 10
5F19	Index 9
5F18	Index 8
5F17	Index 7
5F16	Index 6
5F15	Index 5
5F14	Index 4
5F13	Index 3
5F12	Index 2
5F11	Index 1
5F10	**Index 0 base object, reference object for multiplex channel**

Fig. 4-13:Objects of the multiplex channel with base object 5F10

The permissible depth of a multiplex channel depends on the choice of base objects. The maximum index preset by the master cannot lead from a base object to another data block. This always limits the maximum index to a value of "15" (16 parameter objects).

In the example in section 4.5 "Monitoring fieldbus transmission" on page 4-6 the words 7 to 13 were assigned with static objects and objects 5EA0 and 5EE0 were base objects for the mutliplex channel.

Multiplex depth

The depth of the mutltiplex channel is limited with a maximum index (C-0-0131).

When running up into operating mode the CLC signals an error if a mutliplex object lies outside of the data block of the base object or if a parameter has not been entered for all objects between base object and object with the number base object plus multiplex depth.

The fieldbus slave checks the current setting via the master and changes the mutliplex channel only if the index lies within the allowable value.

(If the bus configuration is done by the master, then the multiplex depth is set with the low byte in the high word of the fieldbus object 5FFE. See Fig. 4-14)

Start offset multiplex channel

The multiplexer of the fieldbus interface must be informed of the place in the process data channel where the multiplex channel starts. The end of the channel is always fixed by the control or status word.

Therefore the first multiplexed word in the real time channel is entered into parameter "fieldbus - start address of multiplex channel“ (C-0-0132). (If the master takes care of the bus configuration, then the start offset is set with the low word of the fieldbus object 5FFE whereby in 5FFE the unit of the offset is specified [byte]. See Fig. 4-14.)

Enable of multiplex channel

Multiplexing is enabled for both data directions separately via two bits in the "fieldbus - control word" (C-0-0129). If a number of actual values are multiplexed for visualization but only a few command values are transmitted by the master to the PLC, then it may not be necessary to multiplex the command values. Set the bit for the enable of the output data to zero at parametrization. Since multiplex depth and multiplex offset apply to both data directions, this saves the tasks of filling up the data word with parameters.

The bits in C-0-0129 correspond to bits 14 and 15 in the fieldbus object 5FFE.

(If the master takes care of bus configuration, then the enable is set with two bits of fieldbus object 5FFE.)

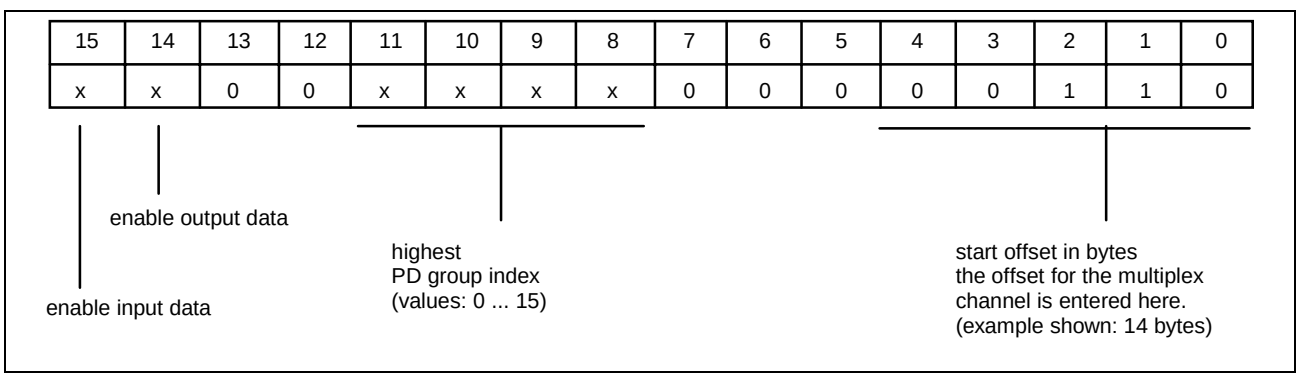

15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
x x 0 0 x x x x 0 0 0 0 0 1 1 0
enable output data
enable input data
highest
PD group index
(values: 0 ... 15)
start offset in bytes
the offset for the multiplex
channel is entered here.
(example shown: 14 bytes)

Fig. 4-14: Start offset multiplex channel object 5FFE

Note: If the PLC changes object 5FFE during the configuration, then the slave module must reconfigure the process data channel. In contrast to changes in standard objects 6000 and 6001 - the bus master automatically informs the slave of the change - the slave module does not know about the change in object 5FFE merely from a reconfiguration.
To avoid a reboot of the slave module, the master can transmit object 6000 or 6001 after 5FFE has been changed.

4.8 Notes on configuring the fieldbus interface

Notes on the fieldbus

- For process input data C-0-0127 and process output data C-0-0128 separate fieldbus objects must be used. Also note wether there is multiplexing or not.
  (Ex.: in C-0-0128: 0x5F10,
  in C-0-0127: 0x5F12
  with C-0-0131 = 3 ***not allowed!***
  Object 5F12 configured for both data directions.)
- Process output data (C-0-0128) and process input data (C-0-0127) always have the same number of words (length of PD channel).
- Process data length 10, 12 or 14 words are not permitted with interbus and 1 word PCP.
- Ensure that the fieldbus master supports the desired process data channel length.

Notes on the slave board

- In fieldbus objects 0x5E80 (DB101, element 1) to 0x5F1F (DB110, element 1) only parameters with 4 byte length can be entered.
  In fieldbus objects 0x5F20 (DB111, element 1) to 0x5F7F (DB116, element 16) only parameters with two byte lengths can be entered. (Ex.: in C-0-0079: CLC:C-0-0001 ***not allowed!***)
- Fieldbus object 0x5FFC (multiplex control word) is only permitted as process output data (C-0-0128).
- Fieldbus object 0x5FFD (multiplex status word) is only permitted as process input data (C-0-0127).
- A multiplex depth > 1 means it is necessary that the multiplex control word (0x5FFC) is configured as the last word in the process output data (C-0-0128) and the multiplex status word (0x5FFD) as the last word in the process input data (C-0-0127).
- Multiplex depth must be selected so that during multiplexing the data block being multiplexed is not left.
  (Ex.: in C-0-0127: 0x5F12
  with C-0-0131 = 15 ***not allowed!***)
- Multiplex depth and the start address at which word multiplexing starts apply to both data directions (process input and output data).

Notes on SYNAX

- Parameters must be entered in all fieldbus objects made up of data blocks configured in the process data channel (0x5E80 - 0x5F7F). Given multiplexing, parameters must be entered in all fieldbus objects at all levels.
  (Ex.: in C-0-0128: 0x5F10,
  in C-0-0079: empty ***not allowed***!)
- If a fieldbus object of a data block is configured larger than the first element, then parameters must be entered in all elements with lower index.
  (Ex.: in C-0-0128: 0x5F11,
  in C-0-0079: empty, CLC:C-0-0004 ***not allowed***!)
- If in process input data C-0-0127 or in process output data C-0-0128 one of the fieldbus objects 0x5E80 (DB101, element 1) to 0x5F1F (DB110, element 16) if configured for a four-byte parameter, then the fill object 0x0 must be configured.
- Fieldbus objects 0x5F80 to 0x5F9F (X outputs) are only allowed as process input data (C-0-0127).
- Within the multiplex channel, SYNAX parameters may not be assigned to several objects of the process output data in C-0-0128 (in configuration list of the data blocks). Dummy parameters used to fill up the multiplex levels are the only exceptions hereto. Indramat recommends parameters C-0-0066 (4bytes) and C-0-0123 (2bytes) for this purpose.
- For computing time reasons, parameters in the process output data C-0-0128 are only written if the operating data have changed from the operating data last transmitted at this point via the fieldbus. If a parameter is changed via the service interface (or the fieldbus parameter channel or communication channel) which is also cyclically overwritten via the fieldbus, then the cyclical change via the fieldbus could be lost.
  (Ex.: in C-0-0128: 0x5F10,
  in C-0-0079: A01: A-0-0056; with A-0-0056= 30.0; overwritten via SynTop A-0-0056 with 10.0;
  10.0 remains in A-0-0056 until A-0-0056<>30.0 is transmitted via the fieldbus!)
- The real time data of the process data channel is only active in phase 4. This means that only parameters that can be changed in phase 4 can be changed in process output data in C-0-0128. Against that the communication and the parameter channel are active in all phases.

4.9 Fieldbus objects for data exchange

Data exchange at fieldbusses is based on objects which have been clearly identified by their object number. Various object classes are available:

- objects for diagnosis and configuration of the fieldbus card
- objects for inputs and outputs of the CLC
- objects for the transmission of parameters
- objects for data communication
- objects for describing process data

Note: The unit data of fieldbusses Interbus and Profibus are addressed via the object number (Index). The data of a unit is illustrated in the DeviceNet specification in terms of class, instance and attribute. These values must be computed using the object number values listed in the following table (Index). The guidelines on this reads (compare section 7.4 "Object structure"):

$$class = 100 + (Object\ no. - 0x5E70)/16$$

$$instance = (Object\ no. \text{ modulo } 16) + 1$$

$$Attribute = 100$$

Object lists of the individual object classes

In the object lists of the individual object classes below, a few abbreviations are used. Thus

- u16 = unsigned 16 bit
- i32 = 32 bit integer
- PD = process data channel

Objects for diagnoses and configuration of the fieldbus card on the CLC

Designation:	Object no.:	Type	Access from master:	PD:
dummy object	5FF1	u16	RW	Yes
operating mode CLC-D	5FF4	u16	R	Yes
operating mode fieldbus	5FF3	u16	R	Yes
status fieldbus	5FF2	u16	R	Yes
diagnose fieldbus	5FF0	u16	R	Yes
status CLC-D	5FF5	u16	R	Yes
fault code CLC-D	5FF6	u16	R	Yes
control word CLC-D	5FF7	u16	RW	Yes
object address / axis no.	5FF8	u16	R	Yes
reserved	5FF9	u16	RW	Yes
PD monitoring span	6003	u16	RW	No
control word fieldbus	5FFB	u16	RW	Yes
multiplex control word	5FFC	u16	RW	Yes
multiplex status word	5FFD	u16	R	Yes
startoffset multiplex channel	5FFE	u16	RW	No

Fig. 4-15: Objects for diagnosis and configuration of the CLC fieldbus card

Diagnose array 5E7A

Designation	Element No.:	Type:	Access from master:	PD:	Remarks
fault code CLC-D	5E7A.1	u16	R	no	(5FF6)
status CLC-D	5E7A.2	u16	R	no	(5FF5)
diagnose fieldbus	5E7A.3	u16	R	no	(5FF0)
status fieldbus	5E7A.4	u16	R	no	(5FF2)

Fig. 4-16: Diagnose array object 5E7A

Objects for inputs of the CLC-D

Designation: Inputs CLC-D	Object no.:	Type:	Access from Master:	PD:
inputs group 32	5FBF	u16	RW	yes
inputs group 31	5FBE	u16	RW	yes
inputs group 30	5FBD	u16	RW	yes
inputs group 29	5FBC	u16	RW	yes
inputs group 28	5FBB	u16	RW	yes
inputs group 27	5FBA	u16	RW	yes
inputs group 26	5FB9	u16	RW	yes
inputs group 25	5FB8	u16	RW	yes
inputs group 24	5FB7	u16	RW	yes
inputs group 23	5FB6	u16	RW	yes
inputs group 22	5FB5	u16	RW	yes
inputs group 21	5FB4	u16	RW	yes
inputs group 20	5FB3	u16	RW	yes
inputs group 19	5FB2	u16	RW	yes
inputs group 18	5FB1	u16	RW	yes
inputs group 17	5FB0	u16	RW	yes
inputs group 16	5FAF	u16	RW	yes
inputs group 15	5FAE	u16	RW	yes
inputs group 14	5FAD	u16	RW	yes
inputs group 13	5FAC	u16	RW	yes
inputs group 12	5FAB	u16	RW	yes
inputs group 11	5FAA	u16	RW	yes
inputs group 10	5FA9	u16	RW	yes
inputs group 09	5FA8	u16	RW	yes
inputs group 08	5FA7	u16	RW	yes
inputs group 07	5FA6	u16	RW	yes
inputs group 06	5FA5	u16	RW	yes
inputs group 05	5FA4	u16	RW	yes
inputs group 04	5FA3	u16	RW	yes
inputs group 03	5FA2	u16	RW	yes
inputs group 02	5FA1	u16	RW	yes
inputs group 01	5FA0	u16	RW	yes

Fig. 4-17: Objects for CLC-D inputs

Note: The CLC-D inputs are configured in the I/O logic. They correspond to the external fieldbus inputs described in section 4, "Internal and external I/O logic". Example: Object 5FA0 corresponds to the inputs E:X01.01 - E:X01.16

Objects for outputs of the CLC-D

Designation: Outputs CLC-D	Object no.:	Type:	Access from Master:	PD:
outputs group 32	5F9F	u16	R	yes
outputs group 31	5F9E	u16	R	yes
outputs group 30	5F9D	u16	R	yes
outputs group 29	5F9C	u16	R	yes
outputs group 28	5F9B	u16	R	yes
outputs group 27	5F9A	u16	R	yes
outputs group 26	5F99	u16	R	yes
outputs group 25	5F98	u16	R	yes
outputs group 24	5F97	u16	R	yes
outputs group 23	5F96	u16	R	yes
outputs group 22	5F95	u16	R	yes
outputs group 21	5F94	u16	R	yes
outputs group 20	5F93	u16	R	yes
outputs group 19	5F92	u16	R	yes
outputs group 18	5F91	u16	R	yes
outputs group 17	5F90	u16	R	yes
outputs group 16	5F8F	u16	R	yes
outputs group 15	5F8E	u16	R	yes
outputs group 14	5F8D	u16	R	yes
outputs group 13	5F8C	u16	R	yes
outputs group 12	5F8B	u16	R	yes
outputs group 11	5F8A	u16	R	yes
outputs group 10	5F89	u16	R	yes
outputs group 09	5F88	u16	R	yes
outputs group 08	5F87	u16	R	yes
outputs group 07	5F86	u16	R	yes
outputs group 06	5F85	u16	R	yes
outputs group 05	5F84	u16	R	yes
outputs group 04	5F83	u16	R	yes
outputs group 03	5F82	u16	R	yes
outputs group 02	5F81	u16	R	yes
outputs group 01	5F80	u16	R	yes

Fig. 4-18: Objects for outputs of the CLC-D

Note: The outputs of the CLC-D are configured in the I/O logic. They correspond to the external fieldbus inputs described in section 4, "Internal and external I/O logic". Example: Object 5F80 corresponds to the outputs A:X01.01 - A:X01.16

Container objects for 4 byte parameters: Data blocks DB 101 - DB 110 (C-0-0058-C-0-0065, C-0-0078, C-0-0079)

Every container object equals one element of the data block.

To transmit a parameter to a container object the parameter must be entered in the corresponding element of the data block (see "Step 5: Parametrizing the contents of the container objects", page 4-10).

Designation: DB101 - 102 32 bit integer	Object no.:	Type:	Access from Master:	PD:
DB 101 element 16	5E8F	i32	RW	yes
element 15	5E8E	i32	RW	yes
element 14	5E8D	i32	RW	yes
element 13	5E8C	i32	RW	yes
element 12	5E8B	i32	RW	yes
element 11	5E8A	i32	RW	yes
element 10	5E89	i32	RW	yes
element 09	5E88	i32	RW	yes
element 08	5E87	i32	RW	yes
element 07	5E86	i32	RW	yes
element 06	5E85	i32	RW	yes
element 05	5E84	i32	RW	yes
element 04	5E83	i32	RW	yes
element 03	5E82	i32	RW	yes
element 02	5E81	i32	RW	yes
element 01	5E80	i32	RW	yes
DB 102 element 16	5E9F	i32	RW	yes
element 15	5E9E	i32	RW	yes
element 14	5E9D	i32	RW	yes
element 13	5E9C	i32	RW	yes
element 12	5E9B	i32	RW	yes
element 11	5E9A	i32	RW	yes
element 10	5E99	i32	RW	yes
element 09	5E98	i32	RW	yes
element 08	5E97	i32	RW	yes
element 07	5E96	i32	RW	yes
element 06	5E95	i32	RW	yes
element 05	5E94	i32	RW	yes
element 04	5E93	i32	RW	yes
element 03	5E92	i32	RW	yes
element 02	5E91	i32	RW	yes
element 01	5E90	i32	RW	yes

Fig. 4-19: Application-specific objects for parameters: data blocks DB101 - DB102

Designation: DB103 - 104 32 bit integer	Object no.:	Type:	Access from master:	PD:
DB 103 element 16	5EAF	i32	RW	yes
element 15	5EAE	i32	RW	yes
element 14	5EAD	i32	RW	yes
element 13	5EAC	i32	RW	yes
element 12	5EAB	i32	RW	yes
element 11	5EAA	i32	RW	yes
element 10	5EA9	i32	RW	yes
element 09	5EA8	i32	RW	yes
element 08	5EA7	i32	RW	yes
element 07	5EA6	i32	RW	yes
element 06	5EA5	i32	RW	yes
element 05	5EA4	i32	RW	yes
element 04	5EA3	i32	RW	yes
element 03	5EA2	i32	RW	yes
element 02	5EA1	i32	RW	yes
element 01	5EA0	i32	RW	yes
DB 104 element 16	5EBF	i32	RW	yes
element 15	5EBE	i32	RW	yes
element 14	5EBD	i32	RW	yes
element 13	5EBC	i32	RW	yes
element 12	5EBB	i32	RW	yes
element 11	5EBA	i32	RW	yes
element 10	5EB9	i32	RW	yes
element 09	5EB8	i32	RW	yes
element 08	5EB7	i32	RW	yes
element 07	5EB6	i32	RW	yes
element 06	5EB5	i32	RW	yes
element 05	5EB4	i32	RW	yes
element 04	5EB3	i32	RW	yes
element 03	5EB2	i32	RW	yes
element 02	5EB1	i32	RW	yes
element 01	5EB0	i32	RW	yes

Fig. 4-20: Application-specific objects for parameters: data blocks DB103 - DB104

Designation: DB105 - 106 32 bit integer	Object no.:	Type:	Access from master:	PD:
DB 105 element 16	5ECF	i32	RW	yes
element 15	5ECE	i32	RW	yes
element 14	5ECD	i32	RW	yes
element 13	5ECC	i32	RW	yes
element 12	5ECB	i32	RW	yes
element 11	5ECA	i32	RW	yes
element 10	5EC9	i32	RW	yes
element 09	5EC8	i32	RW	yes
element 08	5EC7	i32	RW	yes
element 07	5EC6	i32	RW	yes
element 06	5EC5	i32	RW	yes
element 05	5EC4	i32	RW	yes
element 04	5EC3	i32	RW	yes
element 03	5EC2	i32	RW	yes
element 02	5EC1	i32	RW	yes
element 01	5EC0	i32	RW	yes
DB 106 element 16	5EDF	i32	RW	yes
element 15	5EDE	i32	RW	yes
element 14	5EDD	i32	RW	yes
element 13	5EDC	i32	RW	yes
element 12	5EDB	i32	RW	yes
element 11	5EDA	i32	RW	yes
element 10	5ED9	i32	RW	yes
element 09	5ED8	i32	RW	yes
element 08	5ED7	i32	RW	yes
element 07	5ED6	i32	RW	yes
element 06	5ED5	i32	RW	yes
element 05	5ED4	i32	RW	yes
element 04	5ED3	i32	RW	yes
element 03	5ED2	i32	RW	yes
element 02	5ED1	i32	RW	yes
element 01	5ED0	i32	RW	yes

Fig. 4-21: Application-specific objects for parameters: data blocks DB105 - DB106

Designation: DB107 - 108 32 bit integer	Object no.:	Type:	Access from master:	PD:
DB 107 element 16	5EEF	i32	RW	yes
element 15	5EEE	i32	RW	yes
element 14	5EED	i32	RW	yes
element 13	5EEC	i32	RW	yes
element 12	5EEB	i32	RW	yes
element 11	5EEA	i32	RW	yes
element 10	5EE9	i32	RW	yes
element 09	5EE8	i32	RW	yes
element 08	5EE7	i32	RW	yes
element 07	5EE6	i32	RW	yes
element 06	5EE5	i32	RW	yes
element 05	5EE4	i32	RW	yes
element 04	5EE3	i32	RW	yes
element 03	5EE2	i32	RW	yes
element 02	5EE1	i32	RW	yes
element 01	5EE0	i32	RW	yes
DB 108 element 16	5EFF	i32	RW	yes
element 15	5EFE	i32	RW	yes
element 14	5EFD	i32	RW	yes
element 13	5EFC	i32	RW	yes
element 12	5EFB	i32	RW	yes
element 11	5EFA	i32	RW	yes
element 10	5EF9	i32	RW	yes
element 09	5EF8	i32	RW	yes
element 08	5EF7	i32	RW	yes
element 07	5EF6	i32	RW	yes
element 06	5EF5	i32	RW	yes
element 05	5EF4	i32	RW	yes
element 04	5EF3	i32	RW	yes
element 03	5EF2	i32	RW	yes
element 02	5EF1	i32	RW	yes
element 01	5EF0	i32	RW	yes

Fig. 4-22: Application-specific objects for parameters: data blocks DB107 - DB108

Designation: DB109 - 110 32 bit integer	Object no.:	Type:	Access from master:	PD:
DB 109 element 16	5F0F	i32	RW	yes
element 15	5F0E	i32	RW	yes
element 14	5F0D	i32	RW	yes
element 13	5F0C	i32	RW	yes
element 12	5F0B	i32	RW	yes
element 11	5F0A	i32	RW	yes
element 10	5F09	i32	RW	yes
element 09	5F08	i32	RW	yes
element 08	5F07	i32	RW	yes
element 07	5F06	i32	RW	yes
element 06	5F05	i32	RW	yes
element 05	5F04	i32	RW	yes
element 04	5F03	i32	RW	yes
element 03	5F02	i32	RW	yes
element 02	5F01	i32	RW	yes
element 01	5F00	i32	RW	yes
DB 110 element 16	5F1F	i32	RW	yes
element 15	5F1E	i32	RW	yes
element 14	5F1D	i32	RW	yes
element 13	5F1C	i32	RW	yes
element 12	5F1B	i32	RW	yes
element 11	5F1A	i32	RW	yes
element 10	5F19	i32	RW	yes
element 09	5F18	i32	RW	yes
element 08	5F17	i32	RW	yes
element 07	5F16	i32	RW	yes
element 06	5F15	i32	RW	yes
element 05	5F14	i32	RW	yes
element 04	5F13	i32	RW	yes
element 03	5F12	i32	RW	yes
element 02	5F11	i32	RW	yes
element 01	5F10	i32	RW	yes

Fig. 4-23: Application-specific objects for parameters: data blocks DB109 - DB110

Container objects for 2 byte parameter: Data blocks DB 111 - DB 116 (C-0-0080 - C-0-0085)

Every container object equals one element of the data block.

To transmit a parameter to a container object the parameter must be entered in the corresponding element of the data block (see "Step 5: Parametrizing the contents of the container objects", page 4-10).

Designation: DB111 - 112 Unsigned 16 Bit	Object-no.:	Type:	Access from master:	PD:
DB 111 element 16	5F2F	u16	RW	yes
element 15	5F2E	u16	RW	yes
element 14	5F2D	u16	RW	yes
element 13	5F2C	u16	RW	yes
element 12	5F2B	u16	RW	yes
element 11	5F2A	u16	RW	yes
element 10	5F29	u16	RW	yes
element 09	5F28	u16	RW	yes
element 08	5F27	u16	RW	yes
element 07	5F26	u16	RW	yes
element 06	5F25	u16	RW	yes
element 05	5F24	u16	RW	yes
element 04	5F23	u16	RW	yes
element 03	5F22	u16	RW	yes
element 02	5F21	u16	RW	yes
element 01	5F20	u16	RW	yes
DB 112 element 16	5F3F	u16	RW	yes
element 15	5F3E	u16	RW	yes
element 14	5F3D	u16	RW	yes
element 13	5F3C	u16	RW	yes
element 12	5F3B	u16	RW	yes
element 11	5F3A	u16	RW	yes
element 10	5F39	u16	RW	yes
element 09	5F38	u16	RW	yes
element 08	5F37	u16	RW	yes
element 07	5F36	u16	RW	yes
element 06	5F35	u16	RW	yes
element 05	5F34	u16	RW	yes
element 04	5F33	u16	RW	yes
element 03	5F32	u16	RW	yes
element 02	5F31	u16	RW	yes
element 01	5F30	u16	RW	yes

Fig. 4-24: Application-specific objects for parameters: data blocks DB111 - DB112

Designation: DB113 - 114 Unsigned 16 Bit	Object no.:	Type:	Access from master:	PD:
DB 113 element 16	5F4F	u16	RW	yes
element 15	5F4E	u16	RW	yes
element 14	5F4D	u16	RW	yes
element 13	5F4C	u16	RW	yes
element 12	5F4B	u16	RW	yes
element 11	5F4A	u16	RW	yes
element 10	5F49	u16	RW	yes
element 09	5F48	u16	RW	yes
element 08	5F47	u16	RW	yes
element 07	5F46	u16	RW	yes
element 06	5F45	u16	RW	yes
element 05	5F44	u16	RW	yes
element 04	5F43	u16	RW	yes
element 03	5F42	u16	RW	yes
element 02	5F41	u16	RW	yes
element 01	5F40	u16	RW	yes
DB 114 element 16	5F5F	u16	RW	yes
element 15	5F5E	u16	RW	yes
element 14	5F5D	u16	RW	yes
element 13	5F5C	u16	RW	yes
element 12	5F5B	u16	RW	yes
element 11	5F5A	u16	RW	yes
element 10	5F59	u16	RW	yes
element 09	5F58	u16	RW	yes
element 08	5F57	u16	RW	yes
element 07	5F56	u16	RW	yes
element 06	5F55	u16	RW	yes
element 05	5F54	u16	RW	yes
element 04	5F53	u16	RW	yes
element 03	5F52	u16	RW	yes
element 02	5F51	u16	RW	yes
element 01	5F50	u16	RW	yes

Fig. 4-25: Application-specific objects for parameters: data blocks DB113 - DB114

Designation: DB115 - 116 Unsigned 16 Bit	Object no.:	Type:	Access from master:	PD:
DB 115 element 16	5F6F	u16	RW	yes
element 15	5F6E	u16	RW	yes
element 14	5F6D	u16	RW	yes
element 13	5F6C	u16	RW	yes
element 12	5F6B	u16	RW	yes
element 11	5F6A	u16	RW	yes
element 10	5F69	u16	RW	yes
element 09	5F68	u16	RW	yes
element 08	5F67	u16	RW	yes
element 07	5F66	u16	RW	yes
element 06	5F65	u16	RW	yes
element 05	5F64	u16	RW	yes
element 04	5F63	u16	RW	yes
element 03	5F62	u16	RW	yes
element 02	5F61	u16	RW	yes
element 01	5F60	u16	RW	yes
DB 116 element 16	5F7F	u16	RW	yes
element 15	5F7E	u16	RW	yes
element 14	5F7D	u16	RW	yes
element 13	5F7C	u16	RW	yes
element 12	5F7B	u16	RW	yes
element 11	5F7A	u16	RW	yes
element 10	5F79	u16	RW	yes
element 09	5F78	u16	RW	yes
element 08	5F77	u16	RW	yes
element 07	5F76	u16	RW	yes
element 06	5F75	u16	RW	yes
element 05	5F74	u16	RW	yes
element 04	5F73	u16	RW	yes
element 03	5F72	u16	RW	yes
element 02	5F71	u16	RW	yes
element 01	5F70	u16	RW	yes

Fig. 4-26: Application-specific objects for parameters: data blocks DB115 - DB116

Objects for data communication

Designation: Data exchange objects	Object no.:	Type:	Access from master:	PD:
data exchange object 16 bytes	5E70	array	RW	No
data exchange object 32 bytes	5E71	array	RW	No
data exchange object 64 bytes	5E72	array	RW	No
data exchange object 128 bytes	5E73	array	RW	No

Fig. 4-27: Objects for data communication

Note: Data are acyclically exchanged with these objects via the communication channel. There may not be direct access via object numbers, but rather indirectly via data requests by means of a telegram (see section "Transmission sequence via a data exchange object", page 4-48).

Objects for writing process data

Designation: Process data writing	Object no.:	Type	Access from master:	PD:	Comments:
process input data	6000	PDP	R/RW	no	profile 12 INTERBUS
process output data	6001	PDP	R/RW	no	profile 12 INTERBUS

Fig. 4-28: Objects for process data writing

Note: The fieldbus master specifies, with these objects, which data objects are applied to the inputs and outputs of the process data channel.

4.10 Communication channel

The communication channel supports the exchange of data that do not have to meet real-time demands.

Examples are

- parameters newly set with product change,
- phase transitions (if a parameter is write protected in operating mode),
- read out of diagnoses,
- list parameter such as "set-up speeds" (A-0-0099), "cam shaft profile 1" (P-0-0072) can only be transmitted via the communication channel or in the case of Profibus the parameter channel.

Accessing parameter or phase is embedded in specific protocols and transmitted via the data exchange objects 5E70 - 5E73 (see "Data storage protocol", page 4-32 ff.). Data exchange via these four objects is thus indirect.

All other data objects can be directly accessed via the communication channel (see "Direct access to data objects", page 4-50).

Fieldbus specific aspects of the communication channel

The specific communication channels are:

- PCP channel in Interbus,
- Explicit Message in DeviceNet,
- Profibus-FMS in Profibus.

Note: The communication channel of Profibus is hardly used because the dominant fieldbus masters are not FMS capable. The parameter channel in the Profibus replaces Profibus-FMS (see sec. 5.6).

Data storage protocol (SIS protocol)

The data cannot be directly exchanged via data objects but indirectly via telegrams within data exchange objects 5E70 to 5E73. With these telegrams, the data demands are specified and the data transmitted. Securing the data transmission is the responsibility of the serial Indramat interface protocol (SIS protocol).

The following sections detail the telegram exchange process.

Telegram types

There are two types of telegrams:

Telegram type	Telegram sender
command telegram	master: of the "active" communication partner
reaction telegram	slave: of the "passive" communication partner

Fig. 4-29: Types of telegrams

There are also two types of master command telegrams:

Telegram type	Data direction
SEND telegram (write-request)	write access: data is sent to slave
FETCH telegram (read-request)	read access: data requested by slave

Fig. 4-30: Command telegram

A slave, correspondingly sends a reaction telegram (see "Protocol content (telegram content)", page 4-35).

Telegram content	Access type
transmission status	with error-free write access
transmission status and requested data	with error-free read access
transmission status and error code	with faulty read or write access

Fig. 4-31 Reaction telegram

Long data blocks in the individual types of telegrams must be broken down into several partial telegrams (see "Protocol content (telegram content)", page 4-35).

Structure of the serial Indramat protocol

The serial Indramat protocol is a **binary protocol** with binary protocol contents.

The arrangement of the individual bytes of data from "Word" to "DWord" corresponds to the **Intel agreement.** The **IEEE** format applies to the floating point type.

The serial Indramat protocol is made up of three parts:

- protocol header (or telegram header)
- user data header
- user data

User data and user data header thereby create the protocol content (telegram content).

Command telegram structure

A **SEND telegram** (Write-Request) is made up of protocol header, user data header and user data.

A **FETCH telegram** (Read-Request) is only made up of protocoll and user data header (the user data header to specify read access can be eliminated if it is already specified by the service).

Reaction telegram structure

A **reaction telegram** by the recipient is made up of a protocol header as well as possibly a user data header and user data.

It has, with the exception of a few changes, see section "Protocol header (telegram header)", page 4-34, the same protocol header and may even contain sections of the user data header from the command telegram. The sender can thus clearly allocate a reaction telegram to his command telegram.

The **user data** vary depending on read or write access and a positive or negative result (see section "Protocol content (telegram content)", page 4-35).

Protocol header (telegram header)

The protocol header is made up of 8 bytes defined as follows:

Byte	Name	Definition of Individual Bytes
1	StZ	Start symbol: STX (0x02)
2	CS	This is the checksum byte. It is formed by adding all following telegram symbols as well as the start symbol StZ and then negated. This means the sum of all telegram symbols always equals "0" if the transmission was successful. The checksum check of an SIS telegram can be switched off with bit 2 in parameter "fieldbus - control word" (C-0-0129). The transmission safety check is only assumed by the fieldbus itself in this case and not additionally by the SIS protocol.
3	DatL	The length of the following user data is set here. DatL can be as big as the field length of the data exchange object used minute the 8 bytes for the protocol header. This equals the maximum values for DatL as follows: Object 5E70: 8 byte Object 5E71: 24 byte Object 5E72: 56 byte Object 5E73: 120 byte
4	DatLW	This is the repeat of DatL. The telegram length equals DatLW and protocol header, i.e.: Telegram length = DatLW + 8.
5	Cntrl	Bit 0 - 3: reserved, Bit 4: 0 => command telegram 1 => reaction telegram, Bit 5 - 7: Status of reaction telegram: 000 no error, request could not be processed 001 presently reserved 010 presently reserved 011 presently reserved 100 presently reserved 101 presently reserved 110 global error (see C-0-0046, C-0-0047 and C-0-0048) 111 presently reserved Note: for a command telegram it always applies that Cntrl = 0
6	Dienst	Specifies service that the sender is requesting from receiver or which is executed. 0x00 reserved 0x01 data transmission terminated 0x02 ... 0x8F reserved 0x90 read parameter 0x91 read a list element 0x92 read current SERCOS phase 0x93 ... 0x9C still available 0x9D activate phase switching with SERCOS target phase 0x9E writing a list element 0x9F writing a parameter 0xA0 ... 0xFF reserved
7	AdrS	Address of the transmitter: station number (0 - 127)
8	AdrE	Address of the receiver: station number (0 - 127)

Fig. 4-32: Protocol header structure

Protocol content (telegram content)

Data format

User data are transmitted in Intel format (see section "Data storage protocol (SIS protocol)", page 4-32).

User data header

The user data header describes the type of request. The elements of the user data header are

- control byte
- unit address
- parameter number and type (command telegrams only)
- list offset (command telegrams only)
- status byte (reaction telegrams only)

Control byte

The control byte specifies how a data block element of a parameter is accessed. The transmission of a following telegram is controlled with bit 2 (lists are written in several steps).

The control byte is read out of the command telegram and the reaction telegram copied. The transmission of a following telegram is controlled with bit 2 (lists read in several steps).

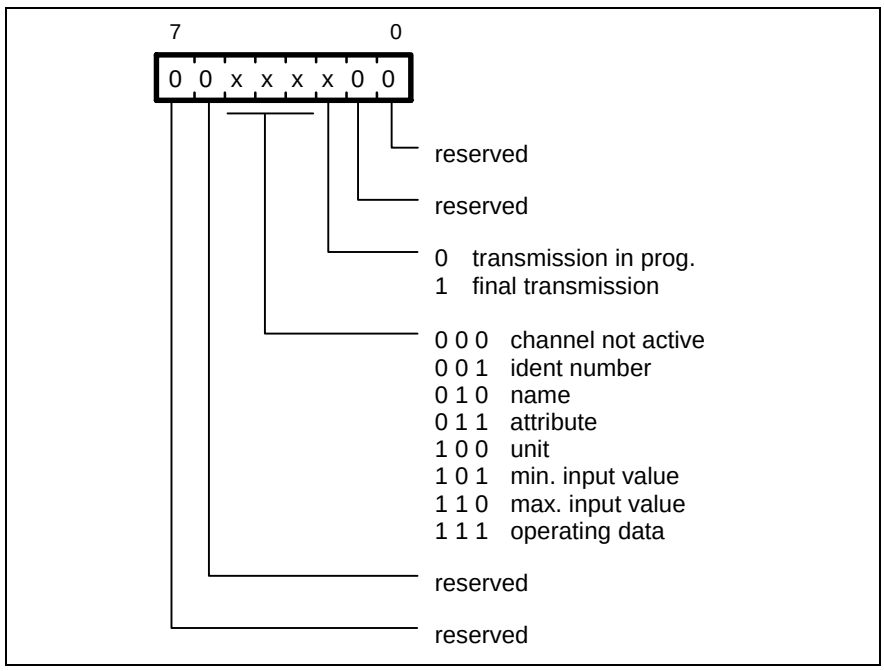


Fig. 4-33: Control data structure

Write access

- of the operating data
- and the ident number (data status read, compare SERCOS interface specification 5.1.3.8) is possible.

Read access

of all elements that describe a parameter is possible. These elements are:

- the attributes,
- minimum and maximum input values,
- the name,
- the unit and
- the operating data.

Unit address

The unit address is read in the command telegram and copied into the reaction telegram.

The serial Indramat interface permits

- direct communication with drives,
- accessing drive parameters via the CLC.

Given communication with a SERCOS master (e.g., CLC) implementing a fieldbus interface, then the master must be informed as to which unit the request relates to. This unit can be the SERCOS master itself or any of the drives it controls.

The address set at the drive controller or "0" are transmitted.

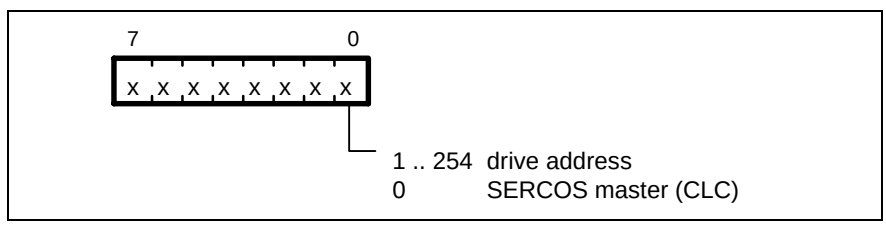


Fig. 4-34: Unit address

Parameter number and type

The parameter number has the form determined in the SERCOS interface specification. To be able to also address control parameters, one byte is set ahead of the address to identify the parameter type.

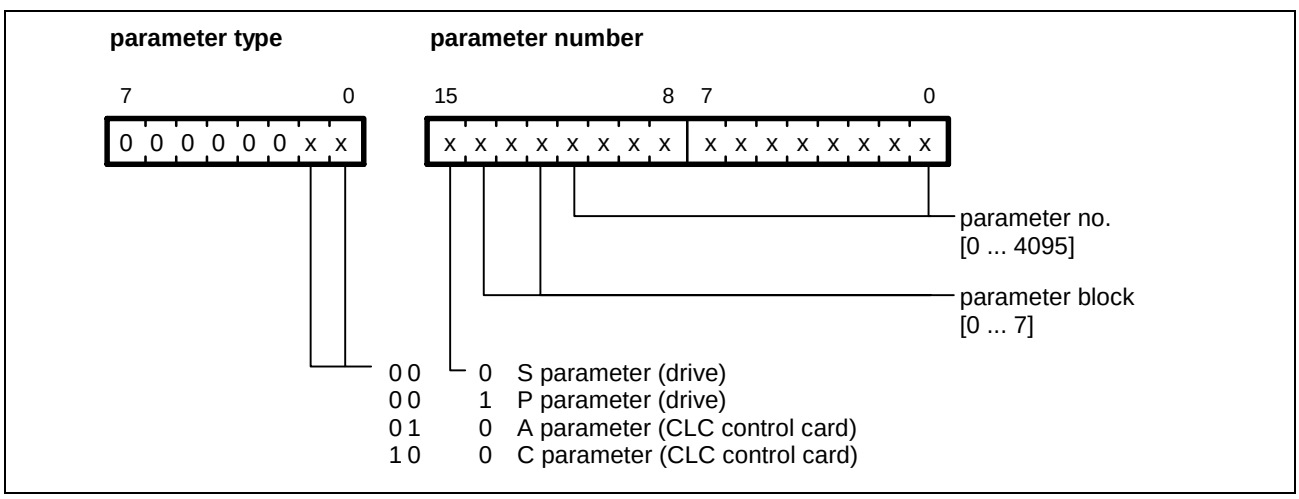


Fig. 4-35: Parameter identification (parameter transmission)

Status byte

The status byte supplies the results of a transmission in the form of a code number.

It generally applies:

Error type	Error code
transmission error-free	0x00
protocol error	0xF0 ... 0xFF
execution error	0x01 ... 0xEF

Fig. 4-36: Error types

whereby

Protocol error	Code number	Error description
"Invalid service"	0xF0	The service requested is not specified or is not supported by the participant addressed.
"Invalid telegram"	0xF1	The telegram cannot be evaluated. Either an incorrect start character or a reaction telegram has arrived.
"Incorrect telegram length"	0xF2	The lengths in the telegram header do not agree.
"Incorrect checksum"	0xF4	The checksum received does not agree with internal calculations.
"Incorrect following telegrams"	0xF8	The address of the master, the control byte, the axis address of the parameter has changed in the following telegram.

Fig. 4-37: Protocol error

Operating error	Code number	Description of error
"Error during parameter transmission"	0x01	An error occurred while reading or writing a parameter (see below "execution error with parameter transmission")
"Error during phase switching"	0x02	The specified target phase was not achieved (see below "Operating error when accessing SERCOS phase")

Fig. 4-38: Operating error

List offset

The list offset is only specified with the transmission of a single element of a parameter list. It sets the number of bytes the desired element is to be shifted in contrast to the first element within the list.

User data

User data are data to be transmitted. User data elements are:

- CLC mode (target mode of current mode)
- parameter value
- error word with operation error (with reaction telegram only)

Operating error during parameter transmission

Errors occurring during the transmission of a parameter generate an error word in the reaction telegram with a specified error code. In case of a read access this error code will then be issued in lieu of the requested data in the user data field.

Error code	Error message in serial protocol
0x0000	no error
0x0001	service channel not open
0x0009	incorrect access to element 0
0x00A0	"non-permisible request" e.g., an access to S/P parameters in initialization mode
0x00B0	"non-permissible element" e.g., write access only with element operating data
0x00C0	"drive address not permitted" The drive address is larger than permitted or the drive in the SERCOS ring is not active (deactivated or not there)
0x00F0	"fatal software error" A CLC internal error occurred during parameter transmission (see C-0-0041). It has affected data exchange.
0x1001	no IDN available
0x1009	incorrect access to element 1
0x2001	no name available
0x2002	name transmission too short
0x2003	name transmission too long
0x2004	name cannot be changed
0x2005	name presently write-protected
0x3002	attribute transmission too short
0x3003	attribute transmission too long
0x3004	attribute cannot be changed
0x3005	attribute presently write-protected
0x4001	no unit available
0x4002	unit transmission too short
0x4003	unit transmission too long
0x4004	unit cannot be changed
0x4005	unit presently write-protected
0x5001	no minimum input value available
0x5002	minimum input value transmission too short
0x5003	minimum input value transmission too long
0x5004	minimum input value cannot be changed
0x5005	minimum input value presently write-protected
0x6001	no maximum input value available
0x6002	maximum input value transmission too short
0x6003	maximum input value transmission too long
0x6004	maximum input value cannot be changed
0x6005	maximum input value presently write-protected
0x7002	data transmission too short
0x7003	data transmission too long
0x7004	data cannot be changed
0x7005	data presently write-protected
0x7006	data smaller than minimum input value

0x7007	data greater than maximum input value
0x7008	data not correct
0x700C	"data exceeds numeric range" The transmitted value is smaller than zero or greater than the "modulo value" (S-0-0103) in the case of a modulo axis.
0x700D	"data length cannot presently be changed" The data length in current mode cannot be changed.
0x700E	"data length cannot be changed" The length of the data is permanently write protected.
0x700F	"list element not available“. List offset set in SIS services 0x91 or 0x9E exceeds range of list or does not show the start address of a list element.
0x8001	"service channel presently busy (BUSY)“ The desired access was not concluded within a timeout (programmed via C-0-0124) because the service channel, for example, was (still) busy. Data transmission is not conducted.

Fig. 4-39: Operational errors during parameter transmission

Operational errors when accessing CLC mode

Errors occurring during phase switching generate an error word with a specific error code in the reaction telegram. It follows the current phase in the user data field.

Error code	Error message in serial protocol
0x8004	Incorrect phase specified via serial protocol
0xD005	"Phase switching still active" A phase switching presently not possible as one is still active
0xD006	"Phase switching with drive enable not possible" Set for at least one drive - "AF"
0xD007	"Phase switching with rotating master axis not permitted"

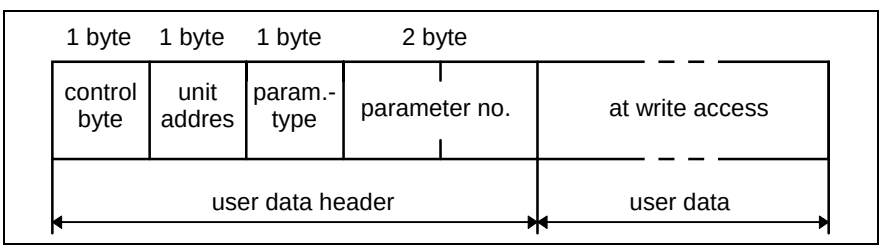
Fig. 4-40: Operational error during phase switching

Transmitting Parameters

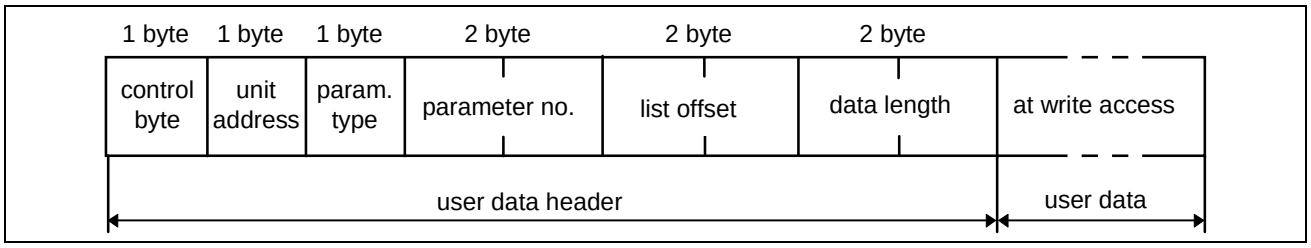
Protocol content when transmitting parameters

The following protocol contents is fixed for parameter transmissions:

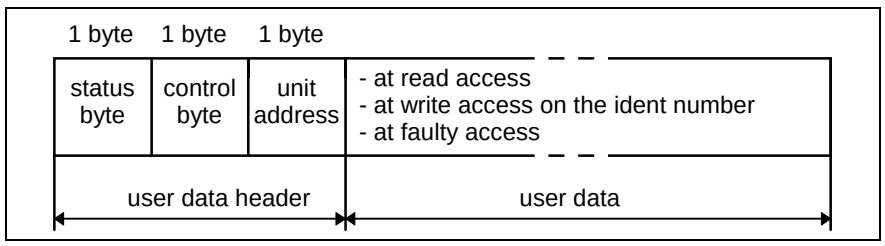
- **Command telegram (standard telegram for parameter transmission):**



- **Expanded command telegram (to transmit individual list elements):**



- **Reaction telegram:**



The data to be transmitted are entered in the user data field. Maximum user data length depends on telegram type:

- **Command telegram:**
  Length of data exchange object - 8{protocol header} - 5{user data header} = max. user data length
- **Reaction telegram:**
  Length of data exchange object - 8{protocol header} - 3{user data header} = max. user data length

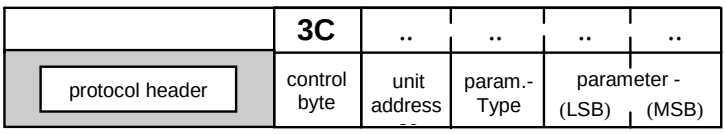
Example of reading a parameter (service 0x90)

Parameters or elements with a length exceeding maximum user data length of the data exchange object are read in steps. Bit 2 in the control byte identifies the current transmission step as a **running** or **final** transmission. A list of four byte data is read. The final data is 0x05F5E100. Data exchange object 5E73 is used.

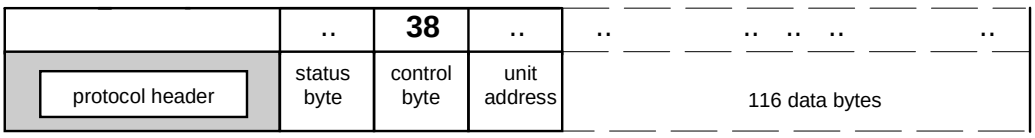
The control word for a transmission is several steps is listed below. The final data of the list is explicitly depicted to illustrate the Intel format of four byte data.

1. Step:

Write-Request of the master with parameter request.

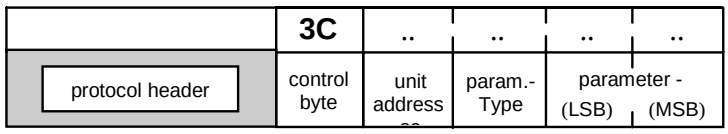


After the first Read-Request of the master, the CLC sends a reaction telegram:

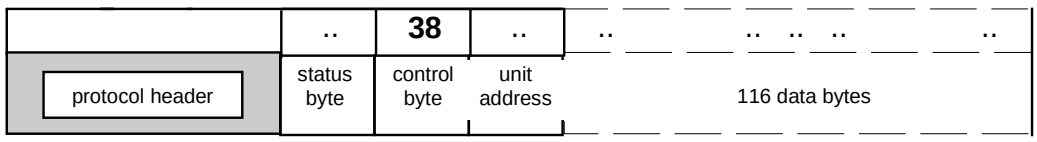


2nd step:

Next Write-Request of the master with the parameter request.



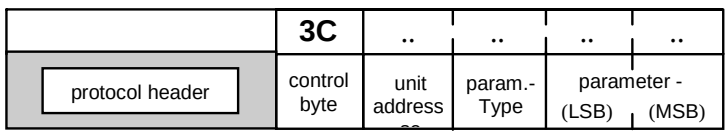
After the first Read-Request of the master, the CLC sends the next reaction telegram (1st following telegram):



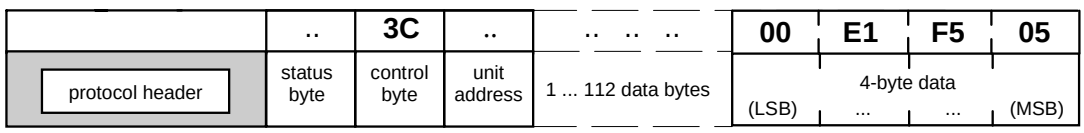
...

Final step

Final Write-Request of the master with the parameter request.



After the final Read-Request of the master, the CLC sends the final reaction telegram (final following telegram):



Note: In SYNAX version 05VRS only a write request from the master is needed to read a list parameter using service 0x90. The complete list, e.g., cam, is read continuously by the read requests.
This algorithm is temporarily supported additional to the algorithm described above in SYNAX version 06VRS. It will be dropped in version 07VRS. It is therefore recommended to perform the master's read request with the new algorithm.

Example for writing into a parameter (Service 0x9F)

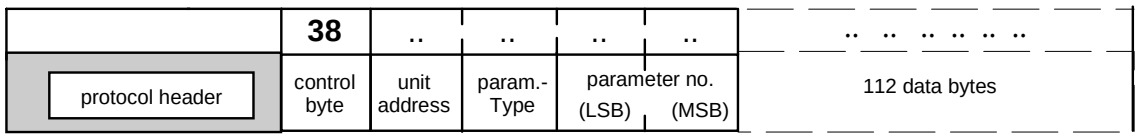
Parameters or elements with a length exceeding maximum user data length of data exchange objects are read in several steps. The transmission of such lists is performed in several steps. Bit 2 in the control byte identifies the current transmission steps as either **in progress** or the **final transmission**.

A list of 4 byte data is to be written. The final data is 0x000186A0. Data exchange object 5E73 is used.

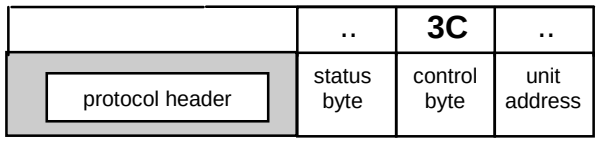
The control word for a transmission is several steps is listed below. The final data of the list is explicitly depicted to illustrate the Intel format of four byte data.

1st step:

Write-Request of the master with the first data block

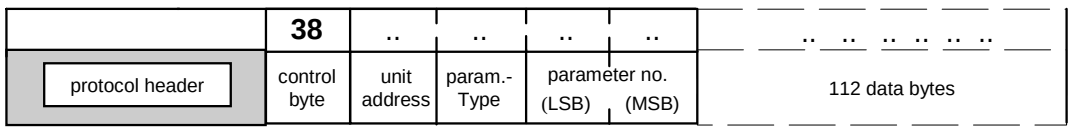


The transmission of data can optionally be checked. The master sends a Read-Request to this end. The CLC responds with a reaction telegram.

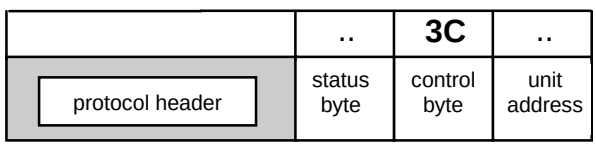


2nd step:

Write-Request of the master with additional data

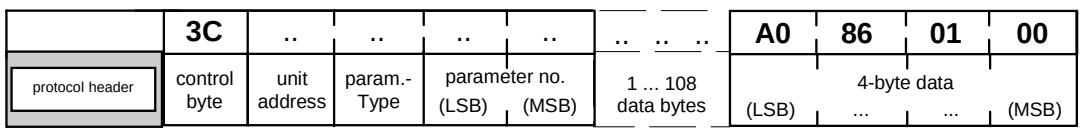


The transmission of data can optionally be checked. The master sends a Read-Request for this purpose. The CLC responds with a reaction telegram.

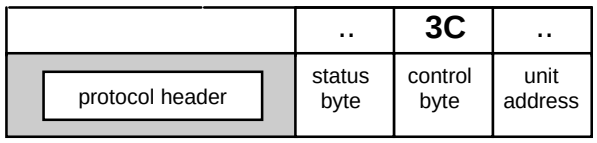


Final step:

Write-Request of the master with the final data block (final following telegram):



After the concluding Read-Request, the master sends the reaction telegram to the CLC:



Note: As long as the SYNAX internal data transmission has not been activated, the read request of a master will be negatively acknowledged as the operational results of the write access has not yet been generated.

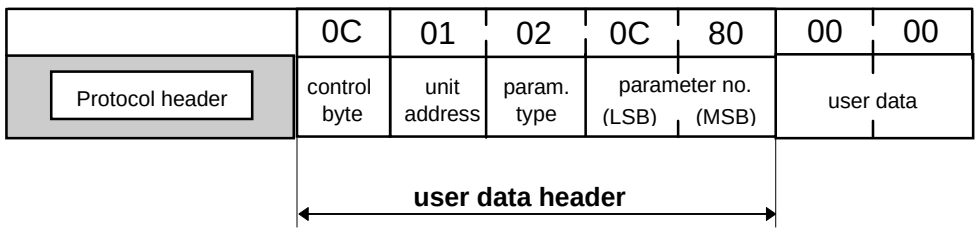
Example for reading the data status of a parameter

To check a procedure command execution, it is necessary to read the data status. This is supplied in an SIS reaction telegram (as per SERCOS interface) when write requesting the ID number of a parameter in the form of user data (service 0x9F).

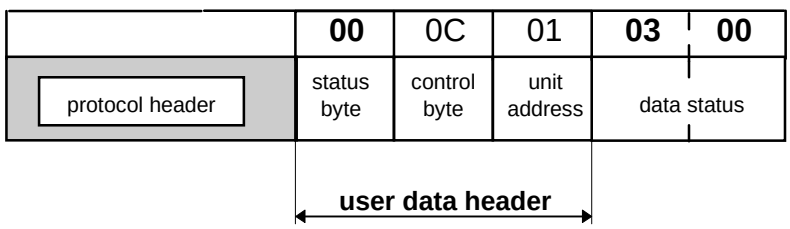
The write request is performed with any value for the 2-byte data of the procedure command.

The following is an example of a check of the data status of the procedure command "C300 command set absolute measurement" (P-0-0012).

Command telegram:



After the master's read request the CLC sends the reaction telegram:



Data status 0x0003 shows that the procedure command is set, enabled and executed successfully.

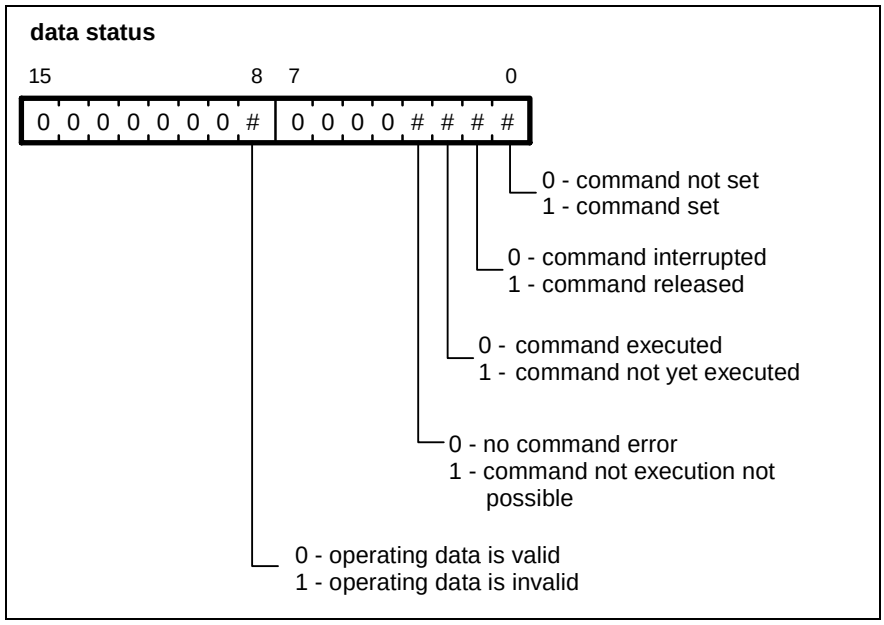

data status
15
8
7
0
0 0 0 0 0 0 0 #
0 0 0 0 # # # #
0 - command not set
1 - command set
0 - command interrupted
1 - command released
0 - command executed
1 - command not yet executed
0 - no command error
1 - command not execution not possible
0 - operating data is valid
1 - operating data is invalid

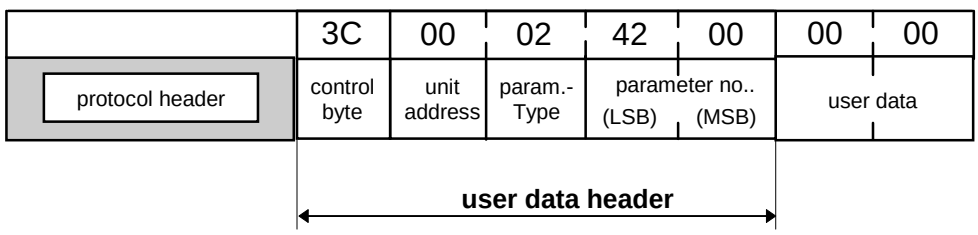
Fig. 4-41: Data status

Example of faulty parameter accessing

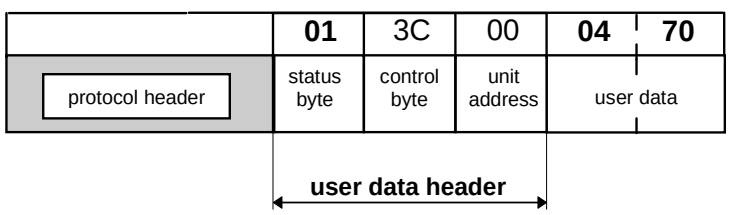
Write access to write-protected CLC parameter "ELS master - actual position value" (C-0-0066).

The master is trying to write a value of 0 into the parameter. SYNAX acknowledges with error message 0x7004 ("data cannot be changed").

Command telegram:



Reaction telegram:



Example of an abort of a write access with following telegrams (service 0x01)

Command telegram:

StZ	CS	DatL	DatLW	Cntrl	Service	Adr.S	Adr.E	Adr.E
02	F9	01	01	00	01	02	00	00

Fig. 4-42: Command telegram "abort", 8 byte protocol header, 1 byte user data, CS, AdrS and AdrE are evaluated on the CLC

This command terminates a write access not yet fully completed. The incomplete data block is discarded. The CLC-D expects no following telegrams and makes itself ready for new data transfer.

Reaction telegram:

StZ	CS	DatL	DatLW	Cntrl	Service	Adr.S	Adr.E	Adr.E
02	E9	01	01	10	01	02	00	00

Fig. 4-43: Reaction telegram "abort“, 8 byte protocol header, 1 byte user data

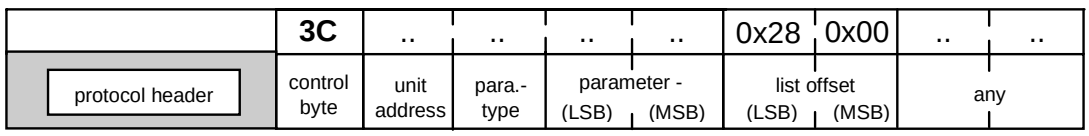
Note: A read access to list parameters is aborted with the same telegram.

Example of reading a list element (Service 0x91)

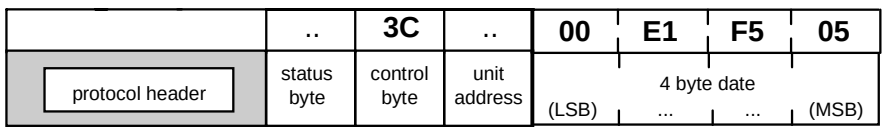
The eleventh element of a list of 4 byte data is to be read. The data is 0x05F5E100. Data exchange object 5E71 must be used.

The following is a control word for a transmission in one step. The list offset equals 40 bytes (= 10 elements). The data of the list is explicitely illustrated to clarify the Intel format of four-byte data.

Write-request of the master with parameter request:



After the read request of the master, the CLC sends the reaction telegram:

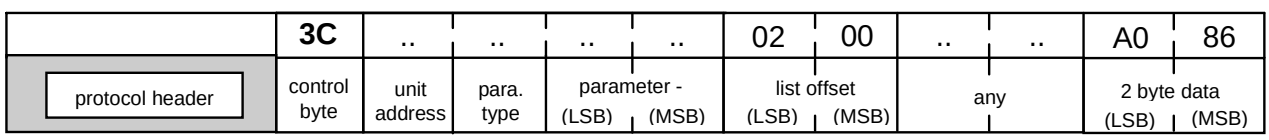


Example of writing a list element (service 0x9E)

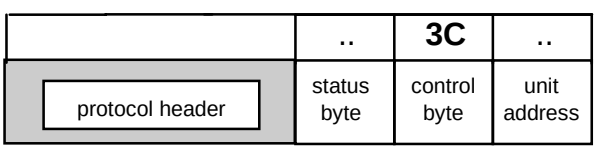
The second element of a line of 2-byte data is to be written. The data is 0x86A0. The list offset equals 2 bytes (= 1 element). Data exchange object 5E71 is used.

The following is the control word for a transmission in one step. The final data of the list is explicitly illustrated to clarify the Intel format of the two byte data.

Write-request of master with the value for the list element:



Optionally, the transmission of the data is checked. The master sends a read request to the master for this. The CLC responds with a reaction telegram:



Transmission of CLC mode

Protocol contents during phase switching

The serial protocol can be used to switch between parametrization and operating mode. This progression is triggered by setting a *communication phase*. It applies:

communication phase 2 = parametrization mode

communication phase 4 = operating mode

The following protocol contents has been set for phase switching:

- **Command telegram**:
  The command telegram has no user data header. One byte is transmitted in the user data. This byte contains the desired phase.
- **Reaction telegram**:
  The reaction telegram contains no user data. Only the status byte is transmitted.

Note: A successfully started phase transition cannot be aborted with a general service termination (0x01).

Example: Switching into operating mode (Service 0x9D)

Progression from parametrization into operating mode is done by setting communication phase 4.

Command telegram:

StZ	CS	DatL	DatLW	Cntrl	Service	Adr.S	Adr.E	User data
02	5B	01	01	00	9D	00	00	04

Fig. 4-44: Command telegram "phase 4 transition“

The command is acknowledged in the first reaction telegram, not the execution of the progression.

Reaction telegram:

StZ	CS	DatL	DatLW	Cntrl	Service	Adr.S	Adr.E	Status byte
02	4F	01	01	10	9D	00	00	00

Fig. 4-45: Reaction telegram "Phase 4 transition“

Right after the first reaction telegram, the master detects with "polling". whether and when the progression is concluded. The current communication phase is repeatedly read (see example for reading a current phase: Service 0x04), until the operating mode or the error is signalled during phase switching.

Example: Switching into parametrization mode (service 0x9D)

Switching from operating into parametrization mode is done by setting communication phase 2.

Command telegram:

StZ	CS	DatL	DatLW	Cntrl	Service	Adr.S	Adr.E	User data
02	5D	01	01	00	9D	00	00	02

Fig. 4-46: Command telegram " Phase 2 transition“

The command is acknowledged in the first reaction telegram, not however the execution of the progression.

Reaction telegram:

StZ	CS	DatL	DatLW	Cntrl	Service	Adr.S	Adr.E	Status byte
02	4F	01	01	10	9D	00	00	00

Fig. 4-47: Reaction telegram "Phase 2 transition"

Right after the first reaction telegram, the master detects whether and when the progression is concluded by means of "polling". The current communication phase is repeatedly read (see example for reading a current phase: service 0x04), until the operating mode or the error is signalled during phase switching.

Protocol contents when reading the current phase

The following applies to reading the current CLC mode:

- **Command telegram:**
  The command telegram does not contain user data.
- **Reaction telegram:**
  The reaction telegram contains a status byte and no more than three user data bytes. Protocol or operational acknowledgement are transmitted in a status byte (compare section "Siemens S5 coupling 3964R", section 1.2). The current communication phase and possibly an error code are in the user data.

Example when reading the current phase (Service 0x92)

Command telegram:

StZ	CS	DatL	DatLW	Cntrl	Service	Adr.S	Adr.E
02	6C	00	00	00	92	00	00

Fig. 4-48: Command telegram "Read phase“

Reaction telegram:

StZ	CS	DatL	DatLW	Cntrl	Service	Adr.S	Adr.E	Status byte	User data
02	56	02	02	10	92	00	00	00	02

Fig. 4-49: Command telegram " Phase 2 transition“

The current communication phase is transmitted in the user data (example: Phase "2").

After phase switching set (see example of phase switching: service 0xF9) the status word displays the status of the progression. The master must repeat read access to the communication phase until the set phase or an error is signalled in the status word.

If the set phase switching cannot be executed, then "error with phase switching" is signalled in the status word of the reaction telegram. The current communication phase and error code are transmitted in the user data. With a non-permitted phase (phase > 4), error code 0x8004 is set. The reaction telegram then looks like this:

	02	04	04	80
protocol header	status byte	current phase	error code (LSB)	(MSB)

The error code in the reaction telegram illustrates the Intel format of 2-byte data.

Transmission sequence via a data exchange object

Selecting the data exchange object

The four data exchange objects 5E70 to 5E73 are available to the master for indirect data exchange via telegrams. These objects each represent byte arrays of varying lengths.

Data exchange object	Data length (in bytes)
5E70	16
5E71	32
5E72	64
5E73	128

Fig. 4-50: Length of the data exchange objects

Depending on the telegram length, any suitable data exchange object can be selected.

Note: The entire data length of the data exchange object must always be transmitted even if the telegram is shorter.

Data request specification with a write-request from the master

As no parameter objects are configured for the transmission of lists and no data object for the CLC mode has been determined, data accessing this types must first be specified. This takes place in a command telegram.

In this command telegram are for a parameter transmission apart from the service also parameter number, type, etc. defined. With write access, the (first) user data are transmitted in the command telegram (see "Protocol header (telegram header)", page 4-34 and "Protocol content (telegram content)", page 4-35).

The master writes this command telegram using a **write-request** into a data exchange object of suitable length. This makes the data request available to the CLC and it can then be processed. Upon processing, the CLC places a reaction telegram into this data exchange object.

Note: Read acess is standardly requested with data exchange object 5E70. Write access requests depend on user data length. With a cam (P-0-0072) this is typically data exchange object 5E73.

Reading the reaction telegram with a read-request

With a **read-request** to a data exchange object the master can read the reaction telegram. The data exchange object for the individual Read-Requests can be of varying lengths.

The maximum length of a reaction telegram corresponds to the length of the data exchange object previously used by the master. This means that there are critical cases when read accessing must be noted.

Read-Request after read request

After a read request, the requested data must be picked up. Reaction telegram, in this case, is read by the CLC via a Read-Request.

Read requests with follow-up telegrams necessitate a renewed write request (identical command telegram) with each further reaction telegram which must then be fetched by a read request.

In the **control byte** of the reaction telegram (see section "Protocol header (telegram header)", page 4-34) it is identified as to whether it is an **in-progress** or **final** reaction telegram

In the **status byte** of the reaction telegram (see "Protocol header (telegram header)", page 4-34) both **protocol** and **operational errors** can be marked. If an operational eror has occurred, then user data can no longer be picked up.

Note: If the read requests implement different data exchange objects, then the new data exchange object may never be smaller than the previous one. Otherwise, data would be lost with a read request with shorter field lengths as a master picks up fewer user data than the CLC has available to it. Especially important is that the data exchange object for the first read request when reading long lists is not smaller than that one used in the write request!

Read-Request after a write request

After a write request it is necessary to check whether the request was successful. The reaction telegram prepared by the CLC supplies this information.

In the case of write access with following telegrams, a read request for the running command telegrams is optional. The reaction telegram only informs about the error at protocol level. The execution in the CLC simply takes the form of the collection of user data.

After the final telegram, operational errors in the reaction telegrams are also considered as the internal data transmission is executed. This means that the master, after the final telegram, should run a read request in every case with write access.

Note: The data exchange object 5E70 always suffices for a read request in the case of write access.

Examples

Examples for read and write access to parameters and the CLC mode are detailled in section "Protocol content (telegram content)", page 4-35

Note: As long as no reaction telegram of the CLC is available, the CLC denies read requests from the master. The internal data transmission with a cam (P-0-0072) takes at least 4.2 seconds at 2ms SERCOS cycle time.
If the CLC denies a read request, then in object 5FF6 ("Fault code DNF3") bit 11 (0x0800) is set, (see "Diagnosis on the fieldbus interface", page 4-50). If this object is configured in the process data channel, then the master can recognize the status of the communication channel in real-time.

Direct access to data objects

There is direct access to all objects defined on the fieldbus except for parameter and data exchange objects via the communication channel. It must thus be noted that:

- it is not possible to write access data objects already written into via the process data channel
- write access to CLC inputs, not used in the I/O logic (see section "Internal and external I/O logic"), may be permitted but have no effect
- read access to CLC outputs, not used in the I/O logic (see section "Internal and external I/O logic") are permitted but only supply a base load value

4.11 Diagnosis on the fieldbus interface

There are a total of three 16 bit objects available for diagnosis handling on the fieldbus interface as well as an internal 16 bit field and a diagnosis object. The CLC (objects 5FF5 and 5FF6) and the fieldbus card (internal 16 bit field and object 5FF2) each update two of these 16 bit fields.

Using these objects, the fieldbus master can detect the status of the fieldbus interface of the CLC and the CLC can generate its diagnosis.

Objects 5FF0, 5FF2, 5FF5 and 5FF6 are single 16 bit objects that can also be configured in the process data channel.

Note: For the master to be able to recognize the validity of the process data or interfere in the communication channel at any time, at least diagnosis object 5FF5 should be configured in the proces data channel.

Object E7A is an array of all four 16 bit objects and the internal 16 bit field. It makes a diagnosis possible with just one data access and offers information about the states (5FF2 and 5FF5) as well as fault codes (5FF6 and the specific fieldbus problem) of the slave boards.

Note: Object E7A ("diagnosis fieldbus") can only be accessed via the communication channel because it is an array object.

Bit assignment of diagnosis objects 5FF5 and 5FF6

Bit field "Status CLC-D" (object 5FF5)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
x15	x14	x13	x12	---	---	---	---	---	---	---	---	x3	---	x1	x0

x0 Status bit for the **Process data channel (PD channel):**

= 0 --> the process data channel is OK, the data are valid,

= 1 --> there is an error pending for the process data channel, the data are invalid. A precise diagnosis is possible with the help of the 8 lower bits of the bit field "fault code CLC-D" (object 5FF6).
No interference bit for the PD channel is set here. The data are thus not valid because the slave is (still) not ready.

x1 Status bit for the **Communication channel:**

= 0 --> the communication channel is OK, the previous data access was successful.

= 1 --> No error has occurred in the communication channel (data transmission error).
A more precise diagnosis can be obtained with the help of the 8 higher bits of bit field "fault code CLC-D" (object 5FF6).

X3 Status bit for a **global SYNAX error**:

= 0 --> The CLC shows no global SYNAX error.

= 1 --> There is a global SYNAX error. Specific information is listed in the diagnosis parameters C-0-0046, C-0-0047 and C-0-0048.

x12 - x15 **Fieldbus interface specification:**

Bit 15	Bit 14	Bit 13	Bit 12	
0	0	1	0	Interbus
0	1	0	0	Profibus
0	0	1	1	DeviceNet

Fig. 4-51: Fieldbus interface specification

All other bit combinations x12 to x15 are still free.

--- Free status bit.

Bit field "Fault code CLC-D" (object 5FF6)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
---	---	---	y4	y3	y2	y1	y0	---	---	---	x4	x3	x2	x1	x0

The interference bits in object 5FF6 are broken down in 8 bits each for the process data and the communication channel. The lower 8 bits are for the process data channel, the higher for the communication channel.

The interference bits for the process data channel are written first:

The errors in the process data channel are bit coded and show a faulty configuration of the process data or multiplex channels (MUX-). The slave recognizes them by means of the initialization or after a reconfiguration and keeps them pending until a new correct configuration as no sensible cyclical data exchange is possible.

x0 Interference bit for **support of data objects**:

= 0 --> All data objects are supported in the process data channel

= 1 --> at least one data object is not available via the process data channel

x1 Interference bit for **access to data objects**:

= 0 --> access to the data objects if correct

= 1 --> at least one data object has been incorrectly accessed (read or write access not permitted)

x2 Interference bit for **object length of process data:**

= 0 --> the lengths of the process data channel fixed by the master agree with the lengths specified for the fieldbus

= 1 --> the lengths of the process data channel fixed by the master do not agree with the length of at least one data object specified for the fieldbus

x3 Interference bit for **configuration as fieldbus and SYNAX object**:

= 0 --> All parameters are configured in the relevant configuration lists.

= 1 --> At least one parameter is not configured in the relevant configuration list.
A configuration list is incorrectly parametrized or empty.

x4 Interference bit for **multiplex channel length**:

= 0 --> the length of the multiplex channel set in object 5FFE ("start-offset multiplex channel") is permissible

= 1 --> the length of the multiplex channel set in object 5FFE ("start-offset multiplex channel") is not permissible. This state occurs, for example, if the start object and the length of the multiplex channel have been selected so that at least one multiplex object falls into a different object class.

The interference bits for the communication channel are described below. They remain pending until the next correct access to a data object.

If the diagnosis object 5FF6 ("fault code CLC-D") is not configured in the process data channel, then note the following when diagnosing problems:

Note: After an error in communication channel, immediately read diagnosis object 5FF6 ("fault code CLC-D") before further diagnoses to avoid clearing interference bits with next valid access.

---

y0 Interference bit for **support of data objects:**

= 0 --> the data object is supported in the communication channel

= 1 --> the data object is not available via the communication channel

y1 Interference bit for **access to data objects**:

= 0 --> the access to data object was correct,

= 1 --> incorrect access to data object (write request cannot be read)

y2 Interference bit for **write-request with data exchange objects**:

= 0 --> access to data exchange object is correct

= 1 --> a write request is still active via a data exchange object meaning that a new access is not permitted. This conflict can only occur in a multi-master system.

y3 Interference bit for **read-request with data exchange objects**:

= 0 --> access to data exchange object is correct

= 1 --> the data for the read request via data exchange object have not yet arrived
Posible causes are:
- interference in slave system
- faulty receiver address in data telegram (see point y4),
- the read request was too early (e.g., with P-0-0072).

In the last case, the read request must be repeated.

y4 Interference bit for **data content in data exchange object**:

= 0 --> the data telegram has been sent to the correct recipient

= 1 --> the receiving address in the data telegram protocol does not agree with the physical bus address. The telegram is discarded. No reaction telegram can be read (see point y3).

--- Free interference bit.

Bit assignment of diagnose objects 5FF0 and 5FF2

Bit field "status fieldbus" (Object 5FF2)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
x15	x14	---	x12	---	---	---	---	---	---	x5	x4	x3	---	x1	x0

x0, x1 Status bit for **internal (DPR) communication** of the fieldbus slave:

Bit 1	Bit 0	
0	0	a reset has been conducted on the DPR
0	1	the DPR has only been initialized by the fieldbus card
1	0	the DPR is complete, i.e., the CLC has also initialized it
1	1	the internal communication of the fieldbus slave, especially the watchdog function, is working correctly

Fig. 4-52: Status bit for the internal (DPR) communication of the fieldbus slave

x3 Status bit for the **active bus capabilities of** the fieldbus slaves:

= 0 --> the fieldbus slave is not (yet) ready for data exchange

= 1 --> the fieldbus slave can actively participate on the bus

x4 Status bit for **communication channel:**

= 0 --> the communication channel can not (yet) be used

= 1 --> the communication channel is available

x5 Status bit for **reconfiguring the process data channel**:

= 0 --> the process data channel on the fieldbus card is configured

= 1 --> the process data channel is being reconfigured on the fieldbus card at this moment

x12 Status bit for **non-supported SYNAX firmware:**

= 0 --> SYNAX firmware is supported.

= 1 --> SYNAX firmware is not supported. The slave modules support the fieldbus but not the synchronous mechanisms with the CLC.

x14 Status bit for the **process output data (see Profile 12, Interbus)**:

= 0 --> Process output data are invalid.

= 1 --> process output data are valid.

x15 Status bit for the **multiplex channel**

= 0 --> the multiplex channel is not (yet) active

= 1 --> the multiplex channel is active

--- Free status bit.

Bit field "diagnose fieldbus" (Object 5FF0)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
x15	x14	x13	x12	---	---	---	---	x7	x6	x5	x4	x3	x2	x1	x0

x0 - x7 Interface specific **fault code**:

x12 - x15 Specification of the **fieldbus interface**:

Bit 15	Bit 14	Bit 13	Bit 12	
0	0	1	0	Interbus
0	1	0	0	Profibus
0	0	1	1	DeviceNet

Fig. 4-53: Fieldbus interface specification

All other bit combinations x12 to x15 are still free.

--- Free interference bit.

Bit assignment of the diagnosis arrays 5E7A

Bit assignment of these diagnosis arrays equals the bit assignment of the individual objects 5FF6 ("fault code CLC-D"), 5FF5 ("status CLC-D"), 5FF0 ("diagnosis fieldbus") and 5FF2 ("status fieldbus") in the above listed order.

Note: The diagnosis array cannot be applied in the process data channel.

CLC-D diagnoses

The CLC-D diagnosis the following interference and faults which can occur in conjuntion with the fieldbus interface and can then prevent a continuous bus communication:

Fieldbus real time channel active

If the CLC is in operating mode and if data are received within the fieldbus timeout via the fieldbus then the CLC sets outputs "fieldbus - real time channel active“ (_A:C01.08).

This output can be used to switch off the drive enable of individual axes given a bus failure in the I/O logic.

Interference on the fieldbus

This includes all errors that could lead to the setting of a bus-specific interference bit in object 5FF0 ("fault code fieldbus"). The CLC generates the diagnosis

"**no communication via the fieldbus is possible**"

The diagnosis message can be cleared via system input "CLC error clear external communication" (_E:C01.03).

Communication interference between CLC and the interface card of the fieldbus

If both firmware versions of the CLC-D and relevant interface card are incompatible, then no internal communication of both slave boards is built up. In this case, the diagnosis

"**non-supported firmware version of the interface card**"

is generated. Progression of the CLC is prevented till a permitted firmware version is installed on the interface card. This error cannot be cleared.

In both cases, fieldbus communication is interferred with so that the master cannot clear it. A control of the SYNAX application is not possible.

Note: The master recognizes all of these errors and eliminates them. A diagnosis message on CLC-D is not needed.

5 The fieldbus interface Profibus

5.1 Introduction

Section 4 describes the basics that apply to all fieldbuses within SYNAX. This sections outlines the bus-specific features and functions of the Profibus.

The connection of SYNAX to Profibus uses the CLC plug-on card DPF05.

5.2 Functional features and GSD file

GSD file

The features of a Profibus slave are filed in a specific file called "Geräte-Stamm-Daten-Datei". It can be objected from Indramat for DPF05, installed in the projecting tool and automatically checked during project planning.

Functional features

Module DPF05 is outfitted with the following features:

- Profibus-DP combi slave, i.e., Profibus-DP and FMS are supported parallel. It is possible to integrate into the Profibus networks the categories Profibus-DP or Profibus-FMS or a mixture hereof as per DIN 19245-3.
- All data rates are supported as per DIN 19245-3 to 12 Mbit (combi-mode up to 500Kbit).
- Freely configurable process data channel up to 16 words in both directions (configurable via the CLC or FMS services). Dawta consistency over the entire length of the PD channel.
- Monitoring of the process data channel (watchdog function).
- LED diagnostic field in front panel of DPF05 for easy diagnostics of the bus functions and important communication links between DPF05 and CLC-D.
- Implementation of an object structure for simple accessing of variables and parameters of control module CLC-D and drive.
- Upload / download functions via four arrays of 16 to 128 byte data lengths (FMS service).

5.3 Monitoring the fieldbus transmission-behavior with bus failure

As described in Sec. 4.5 the DPF monitors the bus behavior with a watchdog timer so that it can specifically response to a bus failure.

Watchdog function

The PLC determines at run up with a runup parameter whether the watchdog is activated, i.e., whether work is with or without monitoring. The PD monitoring time is, depending on the master used either calculated by the master automatically or set by user and is also set by another runup parameter.

In object

6003 PD monitoring time

the time is displayed in [ms] which was set in runup.

Note: When setting the PD monitoring time note that fieldbus cycles could fail under normal operating conditions.

Error reactions with bus failures

The DPF permits a setting of two error reactions for the process data channel which can meet various demands. Via object

6004 error reaction PD channel

the bus master has two options, namely, the data are frozen or deleted. Default setting is that the data are frozen and the CLC can issue an error reaction.

Note: For a resident storage of new values for fieldbus objects supports object 5E7D is used. Note, however, that the hardware of the module cannot be simply replaced in the event servicing should become necessary.

Output data are retained (default value)

The output data are retained at the end of the monitoring time if object 6004 has a value not equal to 0xFFFF (default value = 0). The last received values thus are always retained.

With an active watchdog, the CLC-D is informed in the fieldbus status register about any bus failures. If the CLC is in operating mode, then output "fieldbus - real time channel active“ (_A:C01.08) is cleared. This CLC output can be used to bring the axes with a bus failure to a standstill.

With a bus return, output "fieldbus - real time channel active“ (_A:C01.08) is set, the output data are briefly cleared by the PLC and the previous values are assumed.

Output data are deleted

If in object 6004 value 0xFFFF is entered, then internally on the DPF the output data are deleted if the fieldbus fails and the monitoring time has run out. In other words, if the drive enable of an axis is initiated directly via an external input, then drive enable is cleared.

With an active watchdog, the CLC-D is informed of a bus failure in the fieldbus status register. If the CLC is in operating mode, then output "fieldbus - real time channel active“ (_A:C01.08) is cleared.

Upon bus return, output "fieldbus - real time channel active" (_A:C01.08) is set and the output data assume the values set by the PLC.

5.4 Configuration of the real time channel

In section 4.6 the configuration of the real time channel was generally discussed. If the parameter channel in Profibus is activated, then the first six words in the process data channel are reserved for this.

Fig. 5-1 shows typical bus assignments for SYNAX applications.

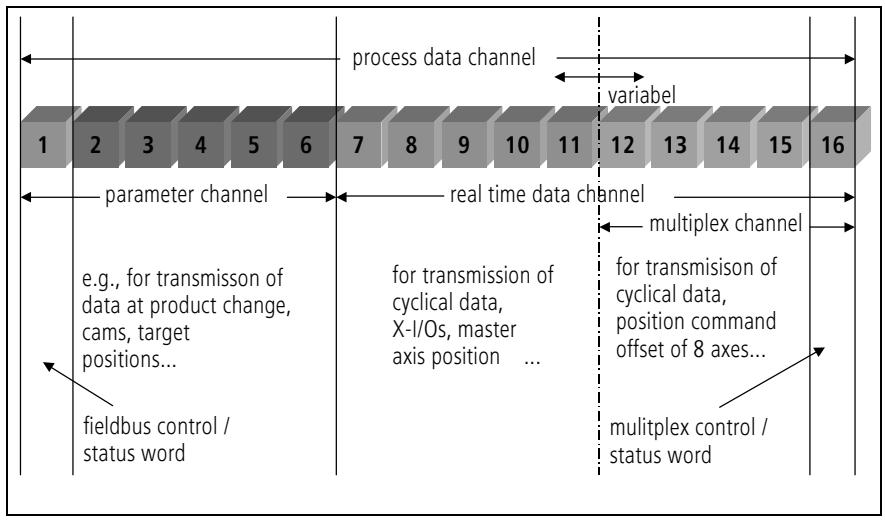


Fig. 5-1: Typical assignment of the 16 words in the process data channel

5.5 Multiplex channel

The general features of the multiplex channel have already been described in section 4.7. This section decribes the bus-specific features of the multiplex channel with Profibus.

Bus-specific are

- the administration of the multiplex levels,
- bit assignment of the multiplex control and status words and
- the sequence in the multiplex channel with a level change.

Administering multiplex levels

With multiplexing are inside SYNAX active -according to the active index-

- the currently received data via the fieldbus entered in a data matrix (data direction PLC -> CLC) and
- the data to be sent copied out of the data matrix onto the bus (data directiom CLC -> PLC).

The administration of the data matrix and thus the multiplex index within SYNAX is possible with Profibus and DPF as well as on CLC. It is set via the SynTop dialog "fieldbus settings“ (correspond with bit 13 in "fieldbus - control word" (C-0-0129)).

Note: With the current hardware the administration of the mutliplex on the CLC is easier and faster for the user. Multiplex administration o the DPF is therefore hardly ever used anymore.

Multiplex administration on DPF

Given multiplex administration on DPF the transition between multiplex levels along can take more than 50 ms. After the change of multiplex levels, the validity of the input data in the new level is acknowledged with DATA_VALID (bit 4 in multiplex status word, see Fig. 5-3). An acknowledge as to whether the CLC has fetched the output data is not generated. To ensure that all data are fetched by the CLC, the master must wait > 70 ms before switching multiplex levels again.

Multiplex administration on the CLC

Multiplex administration on the CLC replaces the DATA_VALID bit with the call back DATA_READY (bit 15 in the mutliplex status word, Fig. 5-3). DATA_READY acknowledges output data and the fetch of the input data on the CLC after a multiplex level change. The PLC can switch the multiplex level again as soon as slave (the CLC) set DATA_READY-bit.

Multiplex control/status word

Fig. 5-2 and Fig. 5-3 show bit assignment of multiplex control and status words.

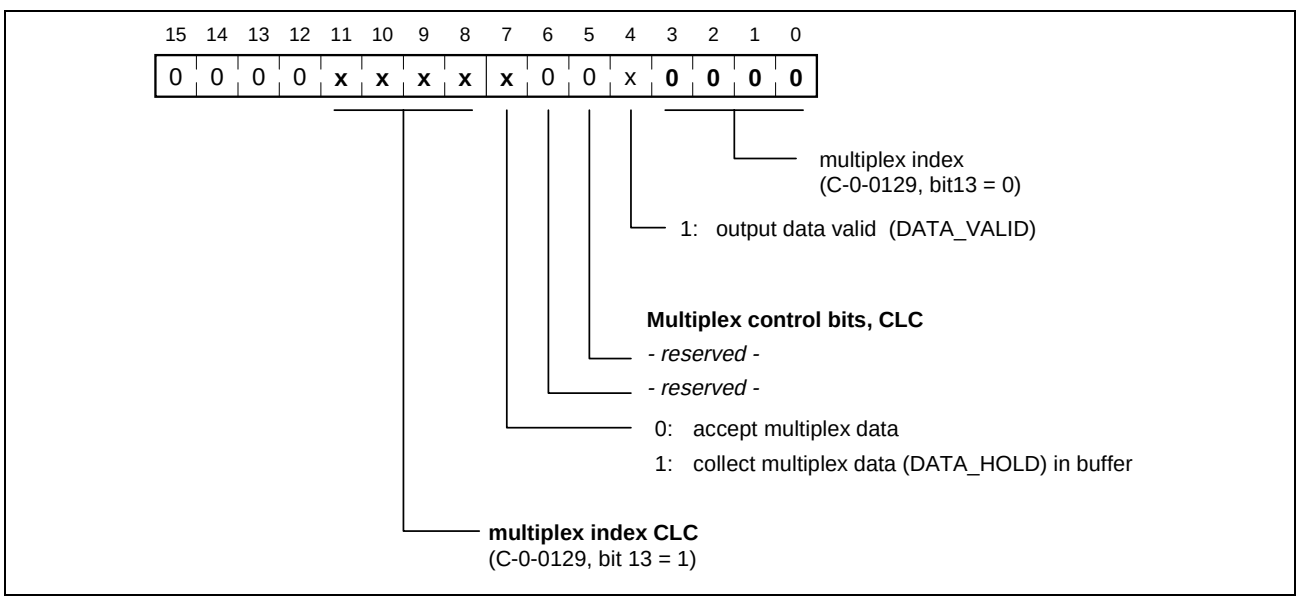

15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
0 0 0 0 x x x x x 0 0 x 0 0 0 0
multiplex index
(C-0-0129, bit13 = 0)
1: output data valid (DATA_VALID)
Multiplex control bits, CLC
- reserved -
- reserved -
0: accept multiplex data
1: collect multiplex data (DATA_HOLD) in buffer
multiplex index CLC
(C-0-0129, bit 13 = 1)

Fig. 5-2: Multiplex control word (with multiplex administration on the CLC)

Multiplex status word

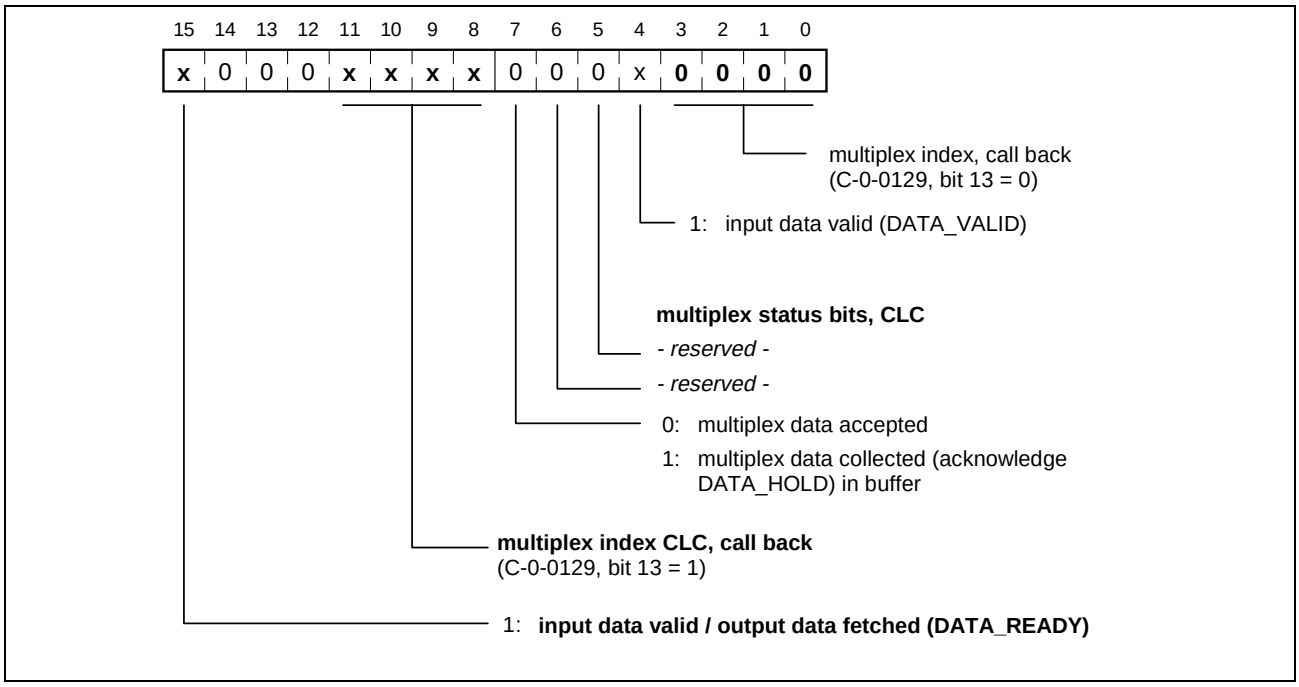

15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
x 0 0 0 x x x x 0 0 0 x 0 0 0 0
multiplex index, call back
(C-0-0129, bit 13 = 0)
1: input data valid (DATA_VALID)
multiplex status bits, CLC
- reserved -
- reserved -
0: multiplex data accepted
1: multiplex data collected (acknowledge DATA_HOLD) in buffer
multiplex index CLC, call back
(C-0-0129, bit 13 = 1)
1: input data valid / output data fetched (DATA_READY)

Fig. 5-3: Multiplex status word (with multiplex administration on the CLC)

Note: The DATA_HOLD bit is evaluated with multiplex administration on DPF (C-0-0129, Bit13=0) as well.

Multiplex administration on the CLC means that the bits have the following definition:

Multiplex index CLC

The PLC sets the index in the control word, CLC acknowledges the index in the status word.

DATA_HOLD, acknowledge DATA_HOLD

For command values transmitted in several bus cycles over changing multiplex levels data consistence can be achieved with the bit DATA_HOLD in the control word. DATA-HOLD is acknowledged in the status word.

The data of several sequential transmission cycles are collected in the input buffer on the CLC. As long as DATA_HOLD bit is set to "1", the buffer is not read out. Only after ther reset of DATA_HOLD will the new data be accepted in the relevant CLC parameters. New command values become simultaneously effective (in the same communication cycle).

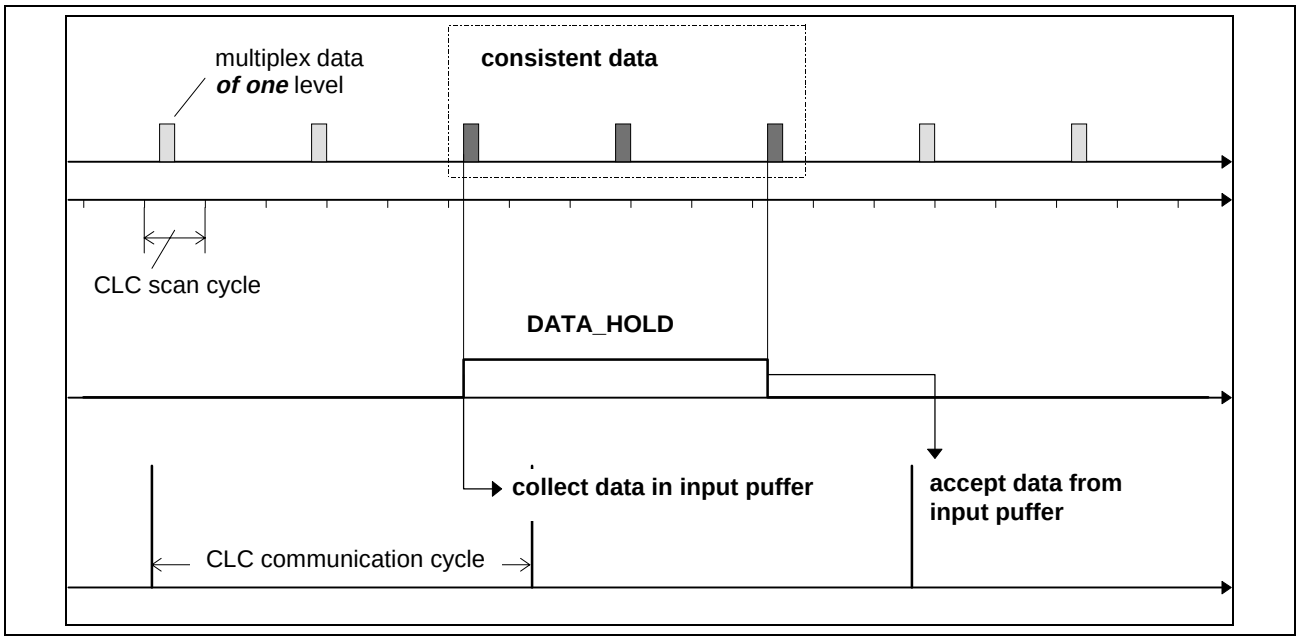


Fig. 5-4: Data consistence in multiplex channel

DATA_VALID (Control word) The master signals in the control word that the command value is valid. If only actual values are to be read, then DATA_VALID = 0 can be set.

DATA_READY (Status word) The CLC signals that valid actual values for the master are available and the new command values have been fetched after a level change.

Given multiplex administration on CLC, bits 0-3 in control word (multiplex index) must be set to "0000“, bits 0-3 in status word (multiplex index, call back) acknowledge "0000“ and bit 4 status word (DATA_VALID) has no meaning.

Sequence in multiplex channel with level change

The level changes in the multiplex channel is subsequently explained with multiplex administration on the CLC.

(Note: Level change in the multiplex channel with multiplex administration on the DPF corresponds to level change in Interbus.)

Output status

The PLC has a multiplex level n.

The DATA_VALID in control word is set if command values are to be fetched by the CLC.

The CLC acknowledges multiplex level n.

The CLC has set DATA_READY.

Step 1

The PLC sets a random multiplex level m (whereby m <= multiplex depth).

The DATA_VALID in control word remains set if in the same fieldbus cycle new command values for the CLC are sent and are to be fetched by the CLC.

Step 2

The PLC waits for the acknowledge of the multiplex level (e.g., XOR comparison in pairs of index bits).

Step 3

The CLC acknowledges level change, sends actual value of new level, receives command values of new level (collects command value if PLC DATA_HOLD is set) and acknowledges both actions with DATA_READY.

Step 4

The PLC fetches actual values of CLC if CLC sends back new level in multiplex status word and DATA_READY is set. The level change is finished.

5.6 Parameter channel on the process data channel

The parameter channel replaces communication channel (FMS) for a master that is only DP-capable. Six words in the process data channel are reserved for this purpose.

The concept in the CLC for data administration is based on data exchange objects 5E73 of FMS. In the parameter channel the telegrams (=contents of 5E73) are broken down into blocks of five words, whereby the first word in the parameter channel (fieldbus control word/status word) coordinates transmission.

For the transmission of a single parameter within a PLC cycle, the SIS protocol was shortened in the SIS protocol to six words, see "Data storage protocol (SIS protocol)". A telegram was also created for accessing fieldbus objects directly. Therefore three transmission formats are used:

- "Indramat SIS short format 1“ for A/C and S/P parameters (theoretically is a transmission in Indramat SIS possible).
- "Indramat-SIS short format 2“ for fieldbus objects on DPF.
- "Indramat-SIS Format“ for phase transitions and service "abort".

Note: The Motorola format must be used for the protocol shell in the parameter channel, Intel for the Indramat SIS protocol. Words and double words were transmitted either swapped or not swapped depending on the protocol they originate from.

If data in SIS format or short format 1 are transmitted, then the rules of indirect access via data exchange object of the communication channel apply. This means that the response of the slave to a write request (fieldbus status word Bit 12=0) for "reading" or "writing" only acknowledges the correct receipt of a telegram.

If a read request follows this (fieldbus status word Bit 12=1), then the master must pick up the data for "reading" or check for correct execution when "writing".

Note: The response of the CLC to write parameter or phase transition does not confirm correct execution. It is thus highly recommended to follow up the transaction directly with a read request as to whether the new value has been correctly accepted by SYNAX after the internal check (see example Fig. 5-11 and Fig. 5-12).

Fieldbus control word and status word

The master uses the fieldbus control word to control the entire transmission procedure via the parameter channel. The slave shows the current status of the transmission in the fieldbus status word.

Idle state

The slave must be brought into its idle state prior to each transmission in the parameter channel. Regardless of the definition of the individual bits, the master specifies the values for the individual bits, i.e., 0x000F. The slave acknowledges the idle state or sets the error bits (see below) as needed.

	FBControl / FBStatus	
M	00 0F	idle state
S	00 0F	acknowledge idle state

Fig. 5-5: Setting basic state; S = slave (CLC), M = master (PLC)

The structure of the FB control word and FB status word is as follows:

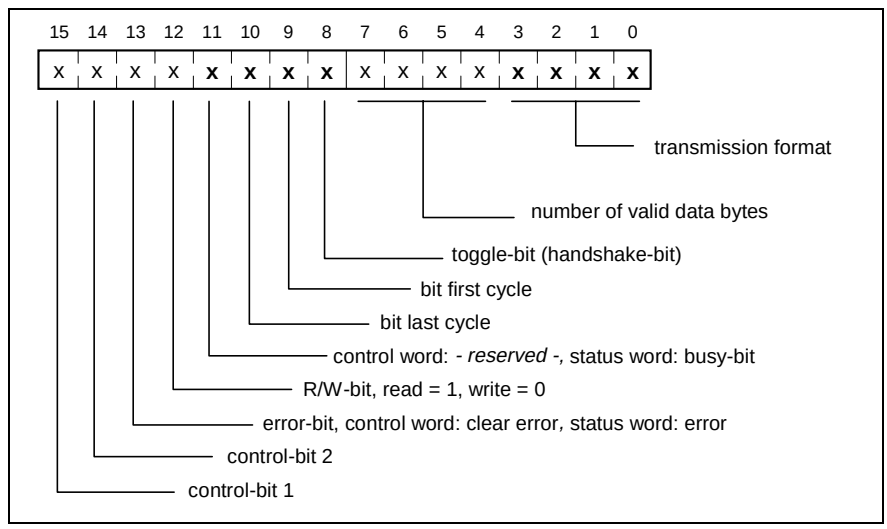

15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
x x x x x x x x x x x x x x x x
transmission format
number of valid data bytes
toggle-bit (handshake-bit)
bit first cycle
bit last cycle
control word: - reserved -, status word: busy-bit
R/W-bit, read = 1, write = 0
error-bit, control word: clear error, status word: error
control-bit 2
control-bit 1

Fig. 5-6: Assigning fieldbus control and status word

The bits have the following meaning:

Control-Bit1 / Control-Bit 2:

If the R/W bit has been set, the read is possible via control bits

- C1=1 and C2=0: length of the process data channel C-0-0126,
- C1=1 and C2=1: length of the parameter channel (bit in C-0-0129),
- C1=0 and C2=1: fieldbus address C-0-0125.

SYNAX signals the relevant values in the low byte of the FB status word.

The control bits generally have no definition because information is also read out via SynTop.

Error-Bit

Via the error bit in the status word the CLC signals an error when transmission format 1 or 2 are applied. Given a transmission error in the standard SIS protocol, the error bit is only set if the error has occurred during the processing sequence within the parameter channel, i.e., in the protocol shell of the parameter channel. (See also "Error codes in the parameter channel", Page 5-17)

The master sets the error bit to clear an error in the slave.

	FBControl / FBStatus	
S	2x xx	slave has set error bit
M	27 00	clear error
S	01 00	error cleared
M	00 0F	idle state
S	00 0F	acknowledge idle state

Fig. 5-7: Example of clearing an error with set toggle bit; S = slave (CLC), M = master (PLC)

Busy-Bit

If the master requests data from the slave, then these are not immediately available on the CLC with S and P parameters. If the master wants to fetch the data while the CLC is collecting data via the Sercos ring, then SYNAX acknowledges the query with a telegram in error format and sets the busy bit. After the idle state is set, the master tries to again fetch the data. This is repeated until the busy bit is not set when fetching data.

Note: General rule of thumb for 4 byte values: The busy bit is only set if PLC cycle time is less than 20 SERCOS cycles.

First cycle, last cycle

To clearly determine the entire length of a telegram and detect the start and end of a complete transmission, the first and last cycle are displayed via one bit each. This clearly defines data transmissions that extend over several cycles.

Transmission type	L Bit	F Bit
first transmission	0	1
last transmisison	1	0
intermediate step	0	0
first and final transmission; one step	1	1

Toggle bit (handshake bit)

To identify a new transmission step and confirm the receipt of data the control and status words include by a toggle bit.

The master toggles the toggle bit if new data are available for the slave during a WRITE access or if the slave requests new data during a READ access.

The slave acknowledges the toggle bit when the slave has fetched the data during a WRITE access or if the data are ready for the master during a READ access.

Regardless of how the toggle bit was previously set, it is cleared by the master once it specifies the idle state.

Number of valid data bytes

The number of valid data bytes are all bytes after the control or status words during a data cycle in the parameter channel.

Note: In contrast to this, byte 3,4 in the SIS protocol header references user data within the entire telegram (compare with section "Protocol header (telegram header)".

Transmission format

By specifying the transmission format it is determined in which telegram mode (or telegram type) the parameters are sent via the bus or are received.

These formats are coded as follows:

Format	Coding
S-/P parameters in short format 1	0000
A parameters in short format 1	0001
C parameters in short format 1	0010
fieldbus objects in short format 2	1101
transmission in SIS protocol	1011

Short format 1 for parameters

Drive and control parameters are generally accessed via *"short format 1".* In the first data block, words 2, 3 and 4 are transmitted in the telegram and user data header and the user data in words 5 and 6. This sends a 2 or 4 byte data in one transmission.

In the case of lists, user data is available in the following blocks starting with word 2.

Data format: ***MOTOROLA***						*Format:* ***INTEL***	
FBControl / FBStatus	Cntrl	service	control byte	unit address	parameter number	user data	user data

Fig. 5-8: Serial protocol "short format 1"

In comparison to the standard SIS protocol irrelevant information such as start symbol and sender address is dropped, a part of the information has been built into the fieldbus control and status words.

If list data are transmitted that are greater than the data exchange object 5E73, then the data is broken down into steps. Into one step, it is possible to write up to 114 or read up to 116 data bytes. (This equals 128 bytes minus telegram and user data header of the standard SIS protocol). These bytes are transmitted in single blocks whereby in the first block of a step only telegram and user data headers in short format 1 may be sent. This means that in the first block of a step, only 4 data bytes may be sent, in each additional block ten data bytes. The sender of the data displays in bit "Last_cycle“ of a block that a step has been completely toggled. In the first block of the last step the final transmission bit is set in the control byte. With bit "Last_cycle“ in the last block of the last step, the receiver recognizes that all data has been received. The idle state is always set between the individual transmission steps.

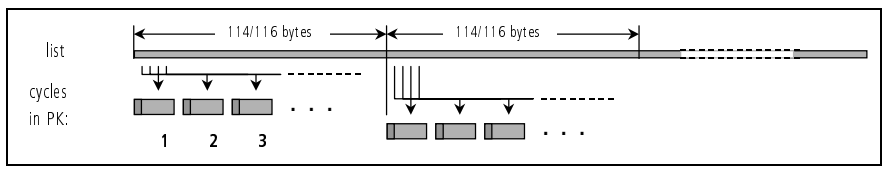


Fig. 5-9: Transmitting a long list

The answer of the slave in short format 1

Two cases must be differentiated for the answer of the slave:

- error-free transmission and
- faulty transmission.

Error-free transmission Given an error-free transmission, the error bit in the FB status word is cleared (E=0) and possible requested data are following at word offset 2.

Faulty transmission Given a faulty transmission, the CLC sets the error bit or the busy bit in the FB status word and sends a telegram in the following format:

Word 1	Word 2	Word 3		Word 4	Word 5	
status word	parameter no.	error class 0x06	0x00	additional error code	Ctrl	status
fieldbus control	error message					

The transmission faults in the parameter channel are discussed separately in section "Error codes in the parameter channel" on page 5-17.

Example 1: Read single data

CLC parameter, data length 4 bytes

Parameter: C-0-0006 "virtual master - speed command 1"

Unit address: 0

Results: Value of parameter: 0x000186A0 = 10.0000 Rpm

	FBControl / FBStatus	Cntrl	Service	Controlbyte	Unit addr.	Parameter number	User data	User data	
S	00 0F	xx	xx	xx	xx	xx xx	xx xx	xx xx	acknowledge idle state
M	07 62	00	90	3C	00	00 06	xx xx	xx xx	start "read parameter" service
S	01 02	xx	xx	xx	xx	xx xx	xx xx	xx xx	acknowledge
M	00 0F	xx	xx	xx	xx	xx xx	xx xx	xx xx	establish idle state
S	00 0F	xx	xx	xx	xx	xx xx	xx xx	xx xx	acknowledge idle state
M	17 02	xx	xx	xx	xx	xx xx	xx xx	xx xx	read request
S	17 A2	10	90	3C	00	00 06	A0 86	01 00	transmission

Fig. 5-10: Example: read parameter C-0-0006

Example 2: Write single data

Drive parameter, data length 4 bytes

Parameter: A-0-0011 "idle speed 0"

Data: 0x000186A0 = 10.0000 Rpm

Unit address: Drive address; in the example: address 2

Results: Error message "data larger than maximum input value“

	FBControl / FBStatus	Cntrl	Service	Control byte	Unit addr.	Parameter number	User data	User data	
S	00 0F	xx	xx	xx	xx	xx xx	xx xx	xx xx	acknowledge idle state
M	07 A1	00	9F	3C	02	00 0B	A0 86	01 00	write parameter
S	01 01	xx	xx	xx	xx	xx xx	xx xx	xx xx	acknowledge
M	00 0F	xx	xx	xx	xx	xx xx	xx xx	xx xx	establish idle state
S	00 0F	xx	xx	xx	xx	xx xx	xx xx	xx xx	acknowledge idle state
M	17 01	xx	xx	xx	xx	xx xx	xx xx	xx xx	read request

Slave sends execution acknowledge with error message:

	FBStatus	Parameter-Nummer	Error Klasse	00	Additional-Error-Code	Ctrl	Status		
S	**3**7 81	00 0B	06	00	**70 07**	D0	01	xx xx	error: date > max. value

Fig. 5-11: Example: Write parameter A-0-0011 with error message "data greater than maximum value"

Example 3: Write list data

Drive parameter, data length 4x4 bytes (short list)

Parameter: A-0-0099 "set-up speed"

Unit address: Drive address; in example: address 3

Data: 0x0010 (actual length of list: 16 bytes), 0x0010 (max. length: 16 bytes)
0x000186A0 = 10.0000 Rpm 0x000186A0 = 10.0000 Rpm
0x000186A0 = 10.0000 Rpm 0x000AAE60 = 70.0000 Rpm

Results: Data successfully written

	FBControl / FBStatus	Cntrl	Service	Control byte	Unit add.	Parameter number	User data	User data	
M	03 A1	00	9F	3C	03	00 63	10 00	10 00	start: "write parameter" service
S	01 01	xx	xx	xx	xx	xx xx	xx xx	xx xx	acknowledge

	FBControl / FBStatus	User data	User data	User data	User data	User data	
M	00 A1	A0 86	01 00	A0 86	01 00	A0 86	transmission element 1-3
S	00 01	xx xx	xx xx	xx xx	xx xx	xx xx	acknowledge
M	05 61	01 00	60 AE	0A 00	xx xx	xx xx	transmission element 3-4
S	01 01	xx xx	xx xx	xx xx	xx xx	xx xx	acknowledge
M	00 0F	xx xx	xx xx	xx xx	xx xx	xx xx	establish idle state
S	00 0F	xx xx	xx xx	xx xx	xx xx	xx xx	acknowledge idle state

	FBControl / FBStatus	Cntrl	Service	Control byte	Unit add.	Parameter number	User data	User data	
M	17 01	xx	xx	xx	xx	xx xx	xx xx	xx xx	start: "read parameter" service
S	17 61	10	9F	3C	03	00 63	xx xx	xx xx	acknowledge, write successful

Fig. 5-12: Example: Write parameter A-0-0099

Example 4: Read list data

Drive parameter, data length 1024x4 byte (long list)

Parameter: P-0-0092 "cam shaft profile 2"

Unit address: Drive address; in the example: address 5

Results: 0x1000 (actual length: 4096 bytes), 0x1000 (max. length: 4096 bytes)

List values: 0, 1, ...3

	FBControl / FBStatus	Cntrl	Service	Control byte	Unit add.	Parameter number	User data	User data	
S	00 0F	xx	xx	xx	xx	xx xx	xx xx	xx xx	acknowledge idle state
M	07 60	00	90	3C	05	80 5C	xx xx	xx xx	start: "read parameter" service
S	01 00	xx	xx	xx	xx	xx xx	xx xx	xx xx	acknowledge
M	00 0F	xx	xx	xx	xx	xx xx	xx xx	xx xx	establish idle state
S	00 0F	xx	xx	xx	xx	xx xx	xx xx	xx xx	acknowledge idle state
M	17 00	xx	xx	xx	xx	xx xx	xx xx	xx xx	read request

Busy signal until list collected on CLC:

	FBControl / FBStatus	Parameter number	Error class	00	Additional error code	Ctrl	Status		
S	1**F** 80	80 5C	06	00	**00 08**	00	00	xx xx	busy signal
M	00 0F	xx xx	xx	xx	xx xx	xx	xx	xx xx	establish idle state
S	00 0F	xx xx	xx	xx	xx xx	xx	xx	xx xx	acknowledge idle state
M	17 00	xx xx	xx	xx	xx xx	xx	xx	xx xx	read request

... etc....

Slave sends min./max. values and first data

	FBControl / FBStatus	Cntrl	Service	Control byte	Unit add.	Parameter number	User data	User data	
S	1**3** A0	10	90	3**8**	05	80 5C	00 10	00 10	transmission of the list length, 1st block, running transmission
M	16 00								next read request

	FBControl / FBStatus	User data	User data	User data	User data	User data	
S	10 A0	00 00	00 00	01 00	00 00	04 00	element 1,2 and half of element 3
M	17 00	xx xx	xx xx	xx xx	xx xx	xx xx	read request

... etc....

Slave sends final data in penultimate step and first data in the last step.

	FBControl / FBStatus	User data	User data	User data	User data	User data	
M	17 00	xx xx	xx xx	xx xx	xx xx	xx xx	read request
S	15 20	02 00	xx xx	xx xx	xx xx	xx xx	bytes 115 and 116 per step
M	00 0F	xx xx	xx xx	xx xx	xx xx	xx xx	establish idle state
S	00 0F	xx xx	xx xx	xx xx	xx xx	xx xx	acknowledge idle state

M	07 60	00	90	3C	05	80 5C	xx xx	xx xx	start: "read parameter" service
S	01 00	xx	xx	xx	xx	xx xx	xx xx	xx xx	acknowledge
M	00 0F	xx	xx	xx	xx	xx xx	xx xx	xx xx	establish idle state
S	00 0F	xx	xx	xx	xx	xx xx	xx xx	xx xx	acknowledge idle state
M	17 00	xx	xx	xx	xx	xx xx	xx xx	xx xx	read request

Note: It is possible with SYNAX 06VRS to ignore two steps in the "read parameter" service" (gray background). With SYNAX 05VRS the "read parameter" service may not be transmitted as otherwise the first data are sent again. As of SYNAX 07VRS the principle of SYNAX 05VRS is no longer supported.

	FBControl / FBStatus	Cntrl	Service	Control byte	Unit add.	Parameter number	User data	User data	
S	1**3** A0	10	90	3**C**	05	80 5C	00 00	37 00	next data, 1st block, last transmission
M	16 00	xx	xx	xx	xx	xx xx	xx xx	xx xx	next read request

... etc....

Slave sends last data in the last step (end)

	FBControl / FBStatus	User data	User data	User data	User data	User data	
M	17 00	xx xx	xx xx	xx xx	xx xx	xx xx	read request
S	15 60	00 00	03 00	00 00	xx xx	xx xx	last 6 bytes of data

Fig. 5-13: Example: read parameter P-0-0092

Short format 2 (fieldbus objects)

Field bus objects can be accessed via *"short format 2":*

Data format: MOTOROLA			
FBControl / FBStatus	Object number	User data	User data

Fig. 5-14: Serial protocol "short format 2"

Example 1: Read object 5FF2

	FBControl / FBStatus	Object number	User data	User data	
S	00 0F	xx xx	xx xx	xx xx	acknowledge idle state
M	17 2D	5F F2	xx xx	xx xx	read request
S	17 6D	5F F2	00 00	40 1B	transmission

Fig. 5-15: Example: read object 5FF2

Example 2: Write object 5FA0

	FBControl / FBStatus	Object number	User data	User data	
S	00 0F	xx xx	xx xx	xx xx	acknowledge idle state
M	07 6D	5F A0	00 00	00 00	write request
S	01 0D	xx xx	xx xx	xx xx	acknowledge

Fig. 5-16: Example: Write object 5FA0

Read field bus configuration with C1,C2

Length of parameter channel

	FBControl / FBStatus	
S	00 0F	acknowledge idle state
M	D7 00	read request
S	D1 0C	answer (length = 12 bytes)

Fig. 5-17: Read process data length

Process data length

	FBControl / FBStatus	
S	00 0F	acknowledge idle state
M	97 00	read request
S	91 18	answer (length = 24 bytes)

Fig. 5-18: Read process data length

Participant address

	FBControl / FBStatus	
S	00 0F	acknowledge idle state
M	57 00	read request
S	51 63	answer (address = 99)

Fig. 5-19: Read participant address

Indramat SIS format

The "Indramat SIS format“ transmission format is needed for phase progressions and the "abort" service. (Theoretically, a transmission of A and C and S and P parameters in SIS format is also possible, but the short format 1 has been designed for this.)

The SIS telegram is broken down into blocks of up to five words which are transmitted with the help of the fieldbus control and status words.

The general structure of Indramat SIS format is described in section "Data storage protocol (SIS protocol)". This is why this section restricts itself to telegrams for phase transitions and terminate services.

Note: The CLC only acknowledges the receipt of phase progression requests. To detect whether the transition has been properly executed or not, the current mode must be polled until the target phase is reached, an error is displayed in the status byte or a timeout has run out.

The reaction telegram

It is necessary to differentiate between three cases for the CLC's reaction telegram, namely,

- transmission without fault,
- faulty transmissions with error in the PK protocol shell and
- faulty transmission with error message in the SIS telegram.

Transmission without fault

Given an error-free transmission, the error bit in the FB status word is cleared (E=0) and possible requested data are following at word offset 2

Faulty transmission with error in the PK protocol shell

Given a faulty transmission with an error in the PK protocol shell, the CLC sets the error bit in the FB status word and sends a telegram in the following format:

Word 1	Word 2	Word 3		Word 4	Word 5	
Status word	Parameter no.	Error class 0x06	0x00	Additional error code	Ctrl	Status
Fieldbus control	Error message					

Faulty transmission with error message in the SIS telegram

Given a faulty transmission with error message in the SIS telegram and the error bit has not been set in the FB status word, then the error is displayed in the status byte.

The errors during a transmission in the parameter channel are discussed separately in section "Data storage protocol (SIS protocol)".

Example 1: Switching into parameter mode

	FBControl / FBStatus	StZ	CS	DatL	DatLW	Cntrl	Service	Adr	Adr	User data		
S	00 0F	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	acknowledge idle state
M	07 9B	02	5D	01	01	00	9D	00	00	02	xx	transition request
S	01 0B	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	acknowledge

Fig. 5-20: Example: Switching into parameter mode

Example 2: Switching into operating mode

	FBControl / FBStatus	StZ	CS	DatL	DatLW	Cntrl	Service	Adr	Adr	User data		
S	00 0F	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	acknowledge idle state
M	07 9B	02	5B	01	01	00	9D	00	00	04	xx	transition request
S	01 0B	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	acknowledge

Fig. 5-21: Swichting into operating mode

Example 3: Reading current phase (phase switching into operating mode active)

	FBControl / FBStatus	StZ	CS	DatL	DatLW	Cntrl	Service	Adr	Adr	Status byte	User data	
S	00 0F	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	acknowledge idle state
M	07 8B	02	6C	00	00	00	92	00	00	xx	xx	start: "read mode" service
S	01 0B	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	acknowledge
M	00 0F	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	establish idle state
S	00 0F	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	acknowledge idle state
M	17 0B	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	read request
S	17 AB	02	54	02	02	10	92	00	00	00	03	actual mode: e.g. "3"
M	00 0F	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	establish idle state
S	00 0F	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	acknowledge idle state
												.....
												.....
M	07 8B	02	6C	00	00	00	92	00	00	xx	xx	start: "read mode" service
S	01 0B	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	acknowledge
M	00 0F	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	establish idle state
S	00 0F	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	acknowledge idle state
M	17 0B	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	read request
S	17 AB	02	54	02	02	10	92	00	00	00	04	acual mode: "4"

Fig. 5-22: Switching into operating mode: read current mode

Example 4: Reading current phase (phase transition not possible)

In example: Error "D007“, phase progression with turning master axis not permitted.

	FBControl / FBStatus	StZ	CS	DatL	DatLW	Cntrl	Service	Adr	Adr	Status byte	User data	
S	00 0F	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	acknowledge idle state
M	07 8B	02	6C	00	00	00	92	00	00	xx	xx	start: "read mode" service
S	01 0B	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	acknowledge
M	00 0F	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	establish idle state
S	00 0F	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	acknowledge idle state
M	17 0B	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	read request
S	13 AB	02	77	04	04	10	92	00	00	**02**	**04**	status byte <> 0 (=2), phase 4
M	01 60	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	fetch 2nd part

	FBStatus	Additional error code							
S	14 2B	07 D0		xx	xx	xx xx	xx	xx	xx xx	error "D007“

Fig. 5-23: Switching into parametrization mode: read the current mode with error message

Example 5: Abort

The abort service terminates all running services. It is needed, e.g., if the transmission of a cam profile was prematurely stopped and a new query has to be started.

	FBControl / FBStatus	StZ	CS	DatL	DatLW	Cntrl	Service	Adr	Adr	User data		
S	00 0F	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	acknowledge idle state
M	07 9B	02	F9	01	01	00	01	02	00	00	xx	terminate service
S	01 0B	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	acknowledge
M	00 0F	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	idle state
S	00 0F	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	acknowledge idle state
M	17 0B	02	5B	01	01	00	9D	00	00	04	xx	reading the execution acknowledgement
S	17 9B	02	E9	01	01	10	01	02	00	00	xx	service successfully completed

Fig-24: "Abort“ service

Error codes in the parameter channel

Overview

Types of errors

There are three different types of errors:

- Error in the sequence of the parameter channel (e.g., "Idle state was not established").
- Error in the SIS protocol sequence (e.g., "invalid Service“). The error is displayed in the status byte, value 0 is in the error code.
- Execution error during phase or parameter transmission (e.g., "Error with parameter transmission“) The error is displayed in the status byte, further information is in the error code.

Fig. 5-25 (Table for determining error codes) lists how to determine the error out of the status byte, the error flag in the field bus control word and the error code of the telegram. The slave answers with each error either in the same format as the request, or if the error flag is set, with a telegram in error format.

Status byte	Errorflag	Error code	Evaluated error code
= 0	0	don´t care	no error
don´t care	1	<> 0	error code (error in parameter channel or execution error)
0x1 or 0x2	0	<> 0	error code (execution error)
<> 0	1	= 0	status byte (SIS protocol error)
<> 0	0	= 0	status byte (SIS protocol error)

Fig. 5-25: Table for determining error codes

For individual transmissions this means:

Drive and control parameters

If an error occurs during a parameter transmission in **"*short format 1"***, then an **error bit is set** and the error code is in word 4 in **Motorola format**.

See Fig. 5-26: Error codes in Motorola format with an error in the sequence of the parameter channel and
Fig. 5-27: Error codes in Motorola format with an execution error during parameter transmission.
Fig. 5-29: Value in the status byte with an SIS protocol error

Fieldbus objects

If an error occurs during parameter transmission in **"*short format 2"***, then an **error bit is set** and the error code is in word 4 in **Motorola format**.

See Fig. 5-26: Error codes in Motorola format with an error in the sequence of the parameter channel.

Phase transition

If an error occurs during phase transition in ***"Standard SIS format"***

- then an error telegram is generated if it is an error in the parameter channel sequence (e.g., idle state not established). The **error bit is set** and the error code is in word 4 in **Motorola format**
  See Fig. 5-26: Error codes in Motorola format with an error in the sequence of the parameter channel.
- a standard SIS data telegram is generated if it is an error during phase transition (e.g., phase transition with turning master axis not allowed) or an error in the SIS protocol. The **error bit** is **not set**, the status byte not equal to 0 and in word 2 of the slave telegram, there is an additional error code in **Intel format**.
  See Fig. 5-28: Execution error in Motorola format with phase transition.
  See Fig. 5-29: Value in the status byte with an SIS protocol error.

Error codes of the parameter channel

Error code	Error description
0x0004	Write access was attempted while the CLC was waiting during an old write access for further data (slave telegrams).
0x0008	Busy signal: data requested not yet on the CLC. *Busy bit is set. Errorflag not set.*
0x000C	Combination of error code 0x0004 and 0x0008. *Busy bit and Errorflag set.*
0x0080	No error.
0x0081	New data being sent, F-bit not yet set.
0x0082	Wrong length specified while reading/writing a field bus object
0x0083	More data expected, but new data sent (F-bit set during transmission of several data blocks).
0x0084	Error in internal status machine.
0x0085	Data length too long (here >128 bytes).
0x0086	Idle state not established.
0x0087	A write command preceded a read command during the transmission of the SIS protocol (in the control word of the parameter channel).
0x0088	An error occured during the data transmssion of the data from/to the CLC.
0x0089	Incorrect checksum detected upon receipt of an SIS telegram from the master.
0x008A	A relayed object number of a field bus object is not defined (valid range: 0x5e74 to 0x5fff).
0x008B	Format specified incorrect or changed between writing/reading of an SIS telegram.
0x008C	The length set in the control byte greater than parameter channel.
0x008D	--
0x008E	L bit not set with configuration query.
0x008F	While transmitting data blocks, attempt was made to query configuration.
0x0090	The format and/or bits 11 to 15 of the control word were changed while transmitting several data blocks.
0x0091	The wrong control bits were set when configuration bits C1 and/or C2 were set (e.g., write configuration presently not possible).
0x0092	Timeout for toggle mechanism of the master (presently not supported).
0x0093	No data can be sent via the slave as no slave is available.
0x0094	FMS service already running. CLC cannot be queried.
0x0095	No data present with a write command.
0x0096	Error in SIS reaction telegram (status byte of SIS reaction telegram ≠ 0x00).
0x0097	Error in the SIS telegram: telegram too long (>128 byte).
0x0098	Error during collection of data blocks. Length 0 was set.
0x0099	The R-Bit not set while data was read.
0x00F0	Timeout during communications with the CLC.

Fig. 5-26: Error codes in Motorola format with an error in the sequence of the parameter channel

Error codes with an execution error of a parameter transmission

Error code	Error messages in the serial protocol
0x0000	No error
0x0001	Service channel not open
0x0009	Incorrect access to element 0
0x00A0	"Non-permissible request" e.g., an access to S/P parameter initialization mode
0x00B0	"Non-permissible element" e.g., write access only with element operating data
0x00C0	"Drive address not permitted" The drive address is greater than permitted or the drive in SERCOS ring not active (deactivated or not available)
0x00F0	"Fatal software error" During a parameter transmission a CLC internal error occurred (see C-0-0041) and it effected data exchange
0x1001	No IDN available
0x1009	Incorrect access to element 1
0x2001	No name available
0x2002	Name transmission too short
0x2003	Name transmission too long
0x2004	Name cannot be changed
0x2005	Name presently write-protected
0x3002	Attribute transmission too short
0x3003	Attribute transmission too long
0x3004	Attribute cannot be changed
0x3005	Attribute presently write protected
0x4001	No unit available
0x4002	Unit transmission too short
0x4003	Unit transmission too long
0x4004	Unit cannot be changed
0x4005	Unit presently write protected
0x5001	No minimum input value available
0x5002	Minimum input value transmission too short
0x5003	Minimum input value transmission too long
0x5004	Minimum input value cannot be changed
0x5005	Minimum input value presently write protected
0x6001	No maximum input value available
0x6002	Maximum input value transmission too short
0x6003	Maximum input value transmission too long
0x6004	Maximum input value cannot be changed
0x6005	Maximum input value presently write protected
0x7002	Data transmission too short
0x7003	Data transmission too long
0x7004	Data cannot be changed
0x7005	Data presently write protected
0x7006	Data smaller than minimum input value
0x7007	Data greater than maximum input value

0x7008	Data not correct
0x700C	"Data exceeds numeric range" The transmitted value is less than zero or greater than the "modulo value" (S-0-0103), given a modulo axis
0x700D	"data length cannot be changed presently" The length of the data cannot be changed in the current mode
0x700E	"Data length cannot be changed" The length of data permanently write-protected.
0x700F	"List element not available“. The list offset set in SIS services 0x91 or 0x9E exceeds range of list or does not show the start address of a list element.
0x8001	"Service channel presently busy (BUSY)“ The desired access had not been completed during a timeout period (programmable via C-0-0124). The service channel was, e.g., (still) busy. Data transmission cannot be executed.

Fig. 5-27: Error codes in Motorola format with an execution error during parameter transmission

Error codes with an execution error of a phase transition

This error code follows the current phase.

Error code	Error messages in the serial protocol
0x8004	Incorrect phase specified via serial protocol
0xD005	"Phase transition still active" phase transition presently not possible as another is active
0xD006	"Phase transition with drive enable not allowed" "AF" set for at least one drive
0xD007	"Phase transition with turning master axis not permitted"

Fig. 5-28: Execution error in Motorola format with phase transition

Values in the Status Byte

With a standard SIS telegram and a telegram in error format, the status byte signals whether there is an error or not. The detailed error codes are signalled separately.

Protocol error	Value in the status byte	Error description
"invalid service"	0xF0	The service requested is not specified or is not supported by the participant addressed.
"invalid telegram"	0xF1	The telegram cannot be evaluated. Either an incorrect start character or a reaction telegram has arrived.
"incorrect telegram length"	0xF2	Both lengths specified in the telegram header do not agree.
"incorrect checksum"	0xF4	The checksum received does not agree with internal calculations.
"incorrect following telegrams"	0xF8	The address of the master, the control byte, the axis address or the parameter number has changed in the following telegram.

Fig. 5-29: Value in the status byte with an SIS protocol error

Execution error	Value in the status byte	Error description
"error with parameter transmission"	0x01	During read or write of a parameter, an error occurred (see below "Execution error with parameter transmission").
"error with phase transition"	0x02	The specified target phase was not reached (see below "Execution error when accessing SERCOS phase").

Fig. 5-30: Value in the status byte with an SIS execution error

5.7 DPF05 board hardware

Front view of the DPF05

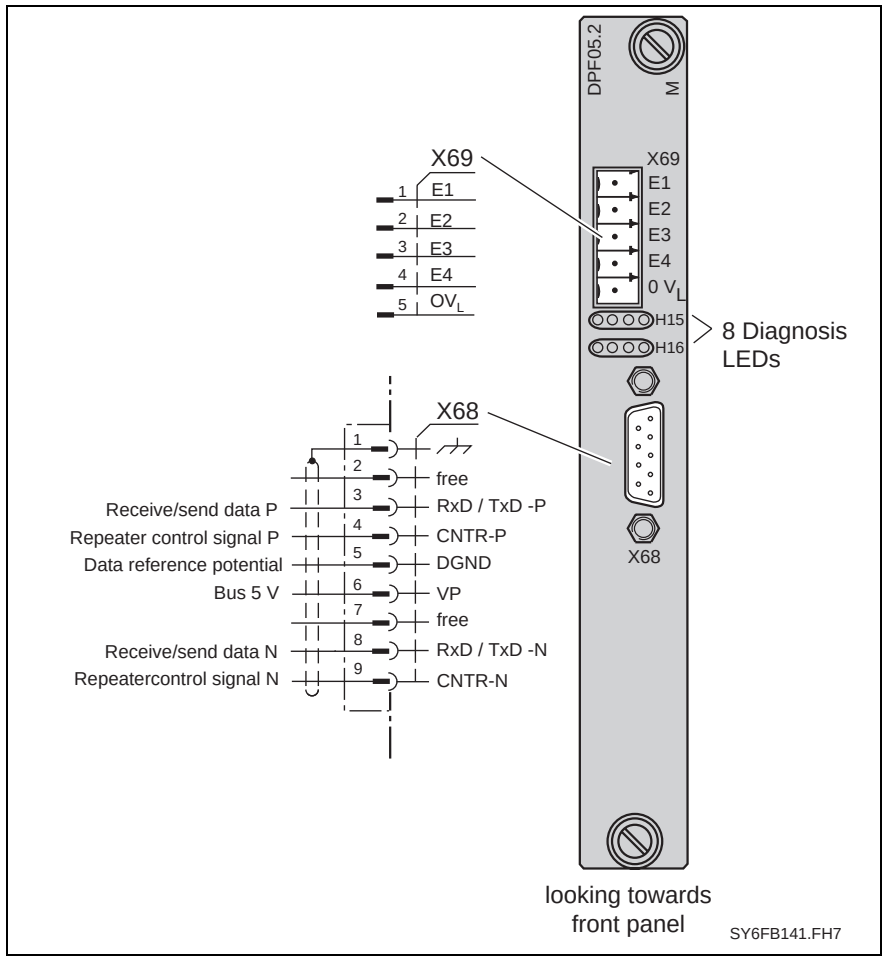


Fig. 5-31: Front view of the DPF05

DPF05 structure

The DPF05 board is conceived as a plug-on board so that it can be directly mounted to the CLC-D control board. Once screwed into place with three guide pins it is one CLC-D unit. This can only be inserted together into the drive or a separate CCD card rack.

Note: Additional boards can be inserted onto DPF05 into the system. This should be noted when dismantling or removing the card rack!

Power is supplied (+5V) by the drive or CCD card rack via a connector on the back of the DPF05. Signals are always exchanged via the connector to the CLC-D.

The interface to the CLC-D is a 68020 bus. Only one DPF05 board can be switched together with the CLC-D.

Note: The Profibus slave board DPF05 may not be operated together with other fieldbus boards.

The DPF05 has the following interfaces:

Interface to the drive or CCD card rack

This interface is used to supply power to the DPF05 board, if the CLC-D does not supply the power.

Interface to CLC-D or other card racks

Information is exchanged between CLC-D and other card racks via this interface. The interface is a 68020 bus interface with partial coding of the address space so that other card boards can also be mounted.

Profibus interface

The Profibus interface meets DIN 19245, sec. 1 requirements for power connections with category A or B lines as per DIN 19245, sec. 3. This supports both type A and B as per DIN 19245, sec. 3.

To ensure EN standards for EMC safety the Profibus interface has been completely galvanically isolated.

As per DIN 19245, sec. 1, module DPF05 is equipped with a 9-pin D-subminiature plug-in connector to accomodate the Profibus.

To transmit bus signals to all remaining bus participants, use connector INS 0450.

Note: The bus coupling as stub cable is directly in the INS 0450. Transmission rates >500Kbit must use this connector.

To maintain bus function, the module operated via a stub cable does not need to be switched on.

Soldering pages or DIL switches are used for the settings.

Signal configuration X68, Profibus connections

X 68	RS 485 reference	Indramat signal name	Signal nach DIN 19245 sec. 3	Definition
1		PE	shield	shield or protective ground
2		free		
3	B / B´	B	RxD / TxD-P	receive/send data - P
4		CNTR-P	CNTR-P	repeater - control signal P
5	C / C´	BUSGND	DGND	data reference potential
6		VP	VP	supply voltage plus (P5V)
7		free		
8	A / A´	A	RxD / TxD-N	receive / send data - N
9		CNTR-N	CNTR-N	repeater - control signal N

Fig. 5-32: Signal configuration X68, Profibus connection

Signal configuration X69, external inputs

The external inputs on X69 are not supported by the CLC-D.

Diagnose of the DPF05

LEDs on the front panel

The DPF05 has eight diagnostics LEDS on the front. They enable the diagnosing of current states of the Profibus and the communication between DPF05 and CLC-D.

Arrangement of diagnostics LEDs

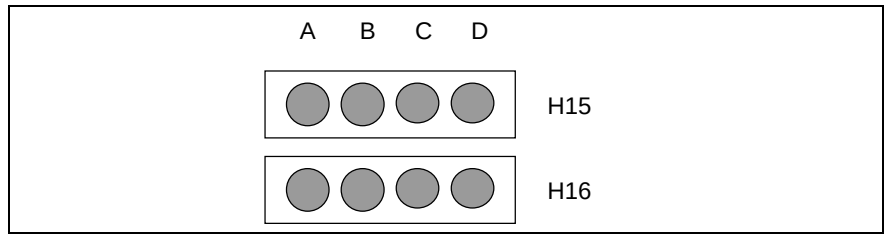


Fig. 5-33: Arrangement of LED diagnoses

Definition of the diagnosis LEDs

- H15A (green) **USYS**
  Power source of Profibus board ok. Power source of DPF05 is either via the CLC-D or the X4 plug-in connector or via the X5 drive interface.
- H15B (green) **BA** Profibus - DP active
  This LED is active if the Profibus DP is active. The cyclical data traffic via Profibus DP is always monitored. If data cycle are detected during time out, then this LED is activated.
- H15C (green) **TR** FMS - Transmission active
  If a FMS data cycle is conducted on this profibus with this participant, then this LED is active.
- H15D (green) presently not used
- H16A (green) **UBUS** P5V Profibus OK
  This LED is active is the drive of the Profibus slave receives +5V. Simultaneously, line VP is applied to +5V pin 6 of the profibus connector. A handheld terminal can be operated. This voltage is taken from the DC/DC converter on the DPF05 board.
- H16B (green) **SW-RUN** Software - RUN
  This LED is used with the LED H16C. It supports diagnoses of the correct software run and the display of successful synchronization between CLC-D and DPF05. Simultaneously LEDs H16B and H16C indicate via their flashing rate the current SERCOS cycle time.
  If synchronization between CLC-D and DPF05 is correct, then the LEDS flash alternately. A rhythmic flashing means the profibus interface on the DPF board is ok, but the synchroniatzion of these boards with the CLC is faulty.
- H16C (green) **SW-RUN** Software - RUN
  See description on LED H16B
- H16D (green) presently not used

6 The fieldbus interface Interbus

6.1 Introduction

Section 4 described the basics that apply to all of SYNAX supported fieldbuses. This section will discuss further bus-specific features and functions of the Interbus.

SYNAX is connected to the Interbus by means of CLC plug-on card DBS03.

6.2 Functional features

Module DBS03 has the following functional features:

- Remote bus module with completely galvanically separated interfaces (EMC safety). The standards of the resistance to interference are met if the connector is completely shielded and the connectors of the incoming and output buses do not come into contact with each other.
- Freely-configurable process data channel for I/O and command/actual values with up to 15 words in both data directions.
- Data consistency along the entire length of the PD channel is only possible if the Interbus master circuit and the PLC can be set to program-synchronous operation. In this case, the transmission in the PCP channel is slower than is the case with asynchronous operation.

Note: To avoid inconsistent data during operation it is necessary to define consistency ranges of 16 to 32 bits between the master connection and the PLC. The user is responsible for setting these consistency ranges according to the alignment in the process data channel, e.g., with the CMD tool in dialog "process data" in column "attached to" for this purpose. The slave module from Indramat does not affect this!

- Interbus slave with PCP 2.0 support. Non-cyclical data exchange between master and slave possible via the PCP channel. One word on the bus in the general sum protocol of the Interbus is reserved for this purpose. This word is generally masked during the I/O assignment in the periphery of the PLC.
- Monitoring the process data channel (watchdog function).
- LED diagnostics field on the front panel of module DBS03 for a simple diagnosis of the bus functions and the most important communication relationships between DBS03 and CLC-D.
- Implementation of an object structure for simplified access to parameters of CLC-D and drives.
- Upload and download function via 4 arrays with data lengths of 16 to 128 bytes (PCP services).

Note: The use of a master module of the 4th generation is recommended!

6.3 Monitoring the fieldbus transmission - behavior with bus failures

As described in section 4.5 the DBS is equipped with a bus monitor that uses a watchdog timer to quickly respond to a bus failure.

Note: The following fieldbus objects for determining action in case of a bus failure can only be write accessed as standard objects by the bus master.

Watchdog function

The PLC and the fieldbus master specify time via object

6003 PD watchdog time

in [ms] after which the error reaction is started after a fieldbus failure. The watchdog is switched off if object 6003 is set to "0xFFFF“. The default value is 300ms.

Note: When setting PD watchdog time it should be taken into account that fieldbus cycles can fail under normal operating conditions.

Error reaction with bus failure

The DBS permits a setting of two error reactions for the process data channel that can meet various demands. Using object

6004 error reaction PD channel

there are two options, namely, the data are either frozen or deleted. The basic setting is to freeze the data and to be able to perform an error reaction by the CLC.

Note: For a non-resident storage of new values for fieldbus objects, use object 5E7D. Note, however, that the hardware of the fieldbus module cannot be simply exchanged if servicing should become necessary.

Output data freezed (default setting)

The output data are freezed at the end of the watchdog time if a value not equal to 0xFFFF has been entered in object 6004 (default value = 0). This means that the last data to arrive at the DBS remain effective.

The CLC-D is informed of a bus failure by an active watchdog in the fieldbus status register. If the CLC is in operating mode, then output "fieldbus - real time channel active“ (_A:C01.08) is cleared. This CLC output can be used to bring the axes to standstill with the I/O logic in case of a bus failure.

With a bus return, output "fieldbus - real time channel active“ (_A:C01.08) is set. The PLC briefly resets the output data to then assume the specified values.

Output data cleared

If 0xFFFF is entered into object 6004, then the output data are internally cleared on the DBS if the fieldbus fails and watchdog time has run out. In other words, if the drive enable of an axis is applied directly via an external input, then the drive enable is cleared.

The CLC-D is informed of a bus failure with an active watchdog in the fieldbus status register. If the CLC is in operating mode, then output "fieldbus - real time channel active“ (_A:C01.08) is cleared.

With a bus return, output "fieldbus - real time channel active“ (_A:C01.08) is set. The PLC briefly resets the output data to then assume the specified values.

6.4 Configuration of the real time channel

Section 4.6, "configuration of the real time channel" described the configuraton of the real time channel in general terms.

The nominated fieldbus interface Interbus does not support all process data lengths up to 15 words. Process data lengths 10, 12 or 14 words are not possible. SYNAX checks the input in parameter "fieldbus: length of process data channel" (C-0-0126) and denies unallowed process data lengths with error "process data are invalid (C-0-0129 / C-0-0128 / C-0-0127 / C-0-0126 / C-0-0131 / C-0-0132 and DBs)" (152).

Note: A process data length of 10, 12 or 14 words in conjunction with the PCP word leads to a transmission length of 11, 13 or 15 words. The Interbus cannot configure these lengths.

6.5 Multiplex channel

In the following section the bus-specific features of the multiplex channel with Interbus are described supplementarily to section 4.7.

Bus-specific is

- the administration of the multiplex levels,
- bit assignment of the multiplex control and status words and
- the sequence of a level switch in the multiplex channel.

Administration of the multiplex level

If the multiplex channel is active, then in accordance with the multiplex index on the SYNAX side

- the data currently received via the fieldbus are entered in data matrix (data direction PLC -> CLC) and
- the current data to be sent out of the matrix are copied onto the bus (data direction CLC -> PLC).

Data matrix administration and thus also the multiplex index within SYNAX with Interbus is done by the DBS. It is set via SynTop dialog "fieldbus settings“ and bit 13 in "fieldbus - control word" (C-0-0129).

Multiplex administration on the DBS

Multiplex administration on the DBS means that switching between two multiplex levels can take up to 50 ms or more. After the multiplex levels have been changed, the validity of the input data at the new level is acknowledged with DATA_VALID (bit 4 in multiplex status word, see Fig. 6-2). An acknowledge as to whether the CLC has fetched the output data is not generated. To ensure that all data are fetched by the CLC the master must wait > 70 ms before trying to change the multiplex levels again.

Multiplex control word/status word

Fig. 6-1 and Fig. 6-2 show bit assignment of the multiplex control and status words in Interbus.

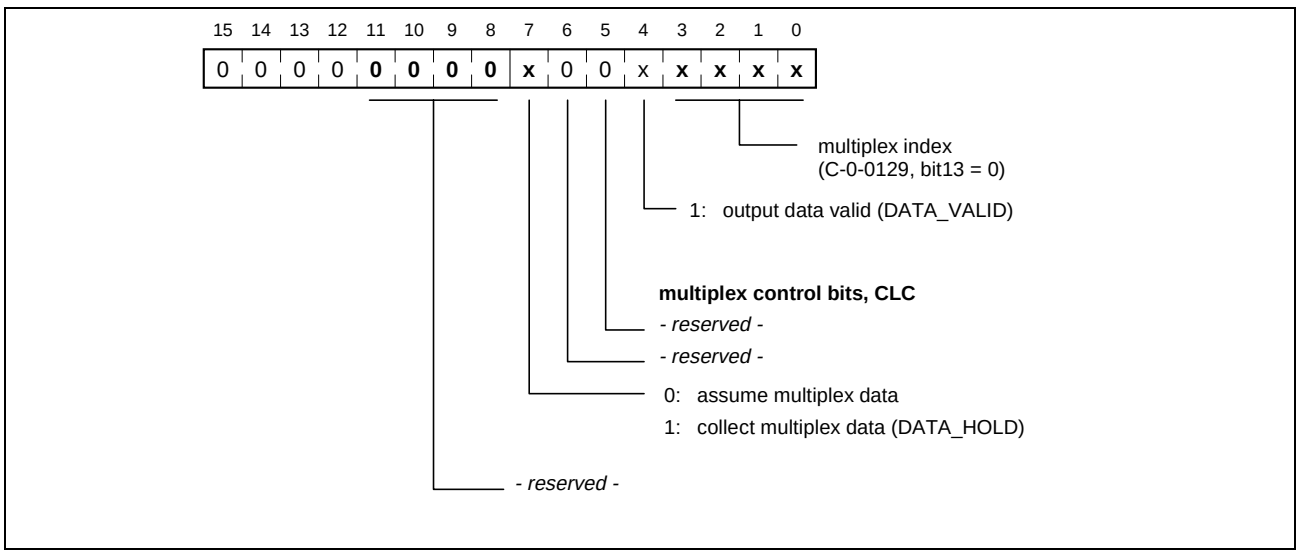

15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
0 0 0 0 0 0 0 0 x 0 0 x x x x x
multiplex index
(C-0-0129, bit13 = 0)
1: output data valid (DATA_VALID)
multiplex control bits, CLC
- reserved -
- reserved -
0: assume multiplex data
1: collect multiplex data (DATA_HOLD)
- reserved -

Fig. 6-1: Multiplex control word

Multiplex status word

Given multiplex administration on the CLC.

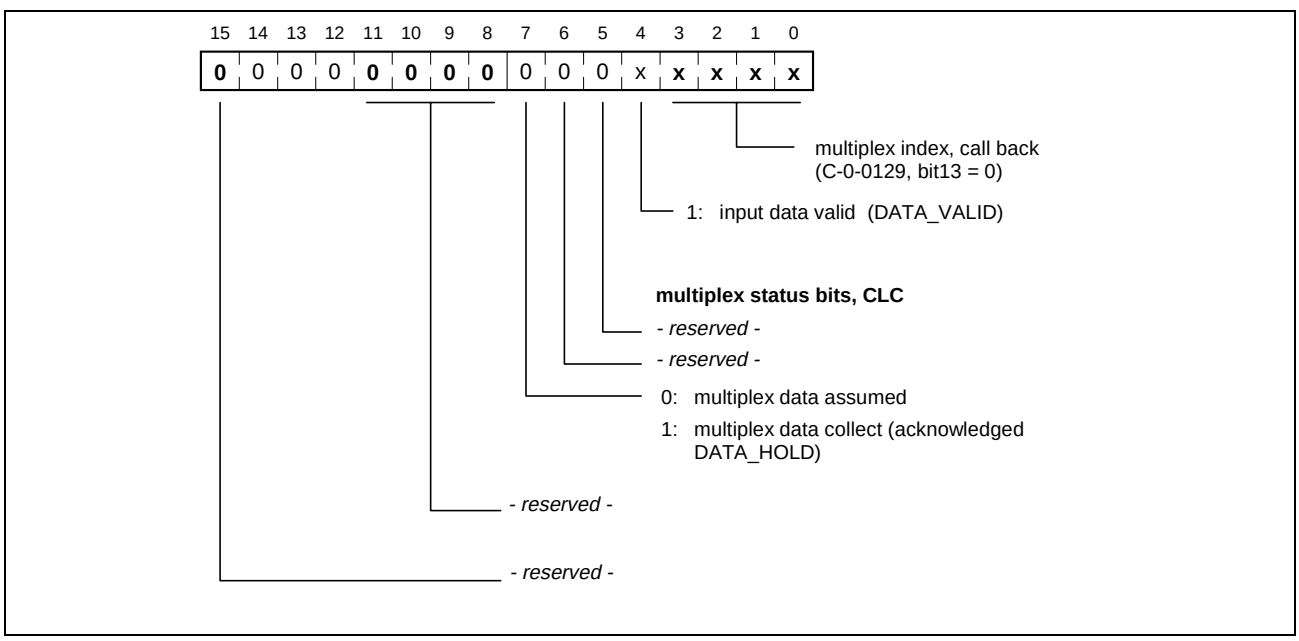

15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
0 0 0 0 0 0 0 0 0 0 0 x x x x x
multiplex index, call back
(C-0-0129, bit13 = 0)
1: input data valid (DATA_VALID)
multiplex status bits, CLC
- reserved -
- reserved -
0: multiplex data assumed
1: multiplex data collect (acknowledged DATA_HOLD)
- reserved -
- reserved -

Fig. 6-2: Multiplex status word

The bits have the following meaning:

Multiplex index

The PLC specifies the level in the control word, the CLC acknowledges the level in the status word.

DATA_HOLD, acknowledge DATA_HOLD

For command values transmitted over several bus cycles and changing multiplex levels, bit DATA_HOLD in the control word can be used to achieve data consistency. DATA-HOLD is acknowledged in the status word.

The data of several sequential transmission cycles are collected in the input buffer on the CLC. As long as the DATA_HOLD bit is set to "1" the buffer will not be read out. Only after a reset of DATA_HOLD will the new data be accepted into the relevant CLC parameters. New command values thus become effective simultaneously (in the same communication cycle).

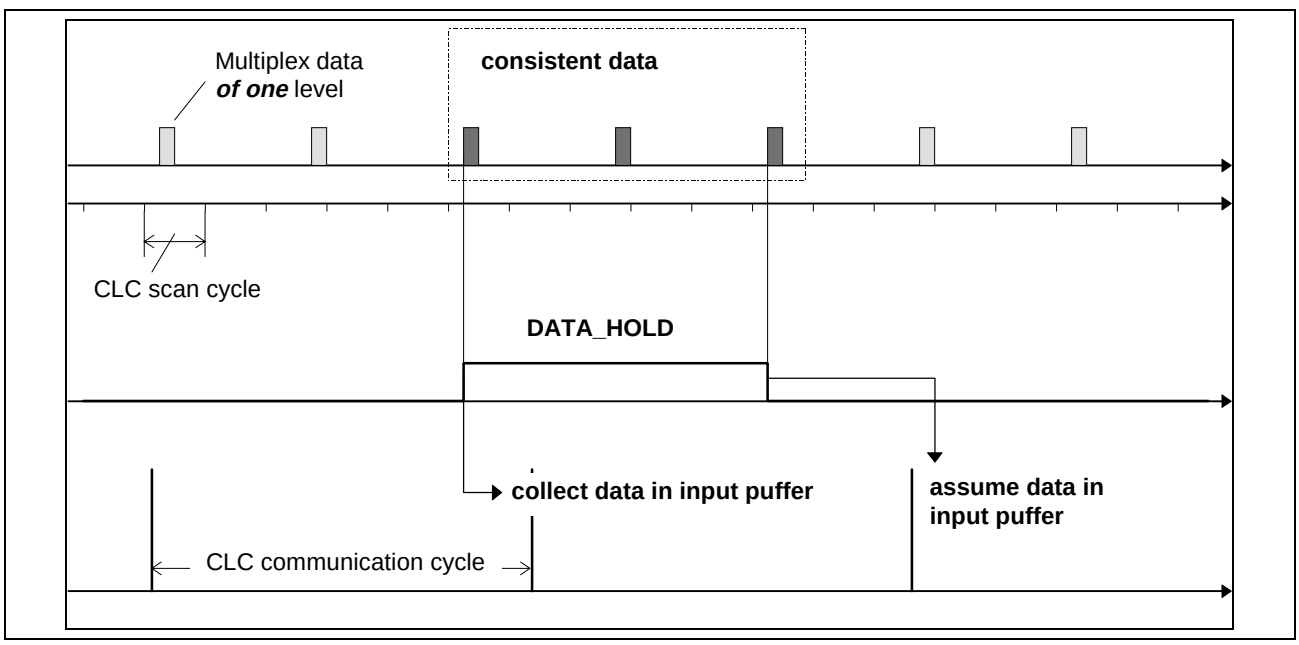


Fig. 6-3: Data consistency in the multiplex channel

DATA_VALID (control word)

The master signals in the control word that the command values are valid. If only actual values can be read, then DATA_VALID = 0 is set.

DATA_VALID (status word)

The CLC signals that valid actual values are ready for the master.

With Interbus, the reserved bits 8-11 in multiplex control word must be set to "0000“, bit 8 to 11 in the status word acknowledges "0000“.

Sequence in the multiplex channel with a level change

Level changes are described below.

Initial state

The PLC has set multiplex level n.

DATA_VALID set in control word if command value to be assumed by CLC.

The CLC acknowledges the multiplex level n.

The CLC sets DATA_VALID.

Step 1

The PLC deletes DATA_VALID in control word.

Step 2

The PLC specifies any multiplex level m, (whereby m <= multiplex depth). In the same fieldbus cycle, the master puts new command values for the CLC on the bus.

The CLC detects the level change and clears DATA_VALID in the status word during the next bus cycle.

Step 3

The PLC sets DATA_VALID in the control word.

Step 4

The PLC waits for acknowledgement of multiplex level (e.g., XOR comparison of index bits). The CLC puts the actual values of the new multiplex levels on the bus and acknowledges the new levels.

Step 5

The CLC sets DATA_VALID in the status word.

Step 6

The PLC detects the level change and DATA_VALID=1 in the status word and fetches the actual value of the CLC. The level change has been concluded. To ensure that all data have been fetched by the CLC, the master must wait > 50 ms to switch multiplex levels again.

6.6 Parameter transmission in the PCP channel

Presettings

Before transmitting parameters in the PCP channel it is necessary to set the lengths of the send and receive buffers to 240 bytes (PDU_SIZE = 0xF0). This can be done in two different ways:

Buffer length set once and stored residently

The length of the send and receive buffers is set once, e.g., with the CMD tool) and stored residently in the communication reference list (CRL) in parameter memory of the master module. With the CMD tool, e.g., this setting uses the context menu of the SYNAX slave in dialog "description“ via button "parameter channel“ for the telegram lengths of sending and receiving.

Setting buffer length during run up

Alternatively, the send and receive buffers are set with every run up of the PLC following the service *Abort_Request* (0x088D). Also dispatched are the services *Load_CRL_Attribute_Loc_Request* (0x0264) PDU_SEND_BUFFER_LENGHT = 0xF0 and *Load_CRL_Attribute_Loc_ Request* (0x0264) PDU_RECEIVE_BUFFER_ LENGHT = 0xF0.

Initialization

During run up the PLC, the PCP channel is brought into a defined state. To do so, the PLC dispatches the non-acknowledged service *Abort_Request* (0x088D). If the CLC acknowledges the successive service *Initiate_Request* (0x008B) without a fault, then initialization is concluded.

Data transmission

To transmit a parameter or the communication phase, the services *Write_Request* (0x0082) and *Read_Request* (0x0081) are used together with the data exchange objects 5E70-5E73 (see section 4.9, "Objects for data communication"). The SIS telegram is entered as data into the data exchange objects (see section 4.10, "Data storage protocol (SIS protocol)").

Write parameter (SIS service 0x9F)

To write a parameter on the CLC, the PLC first sends the service *Write_Request* with SIS telegram content "write parameter“ and fetches the acknowledgement as to whether the data have been successfully written with service *Read_Request* with the SIS telegram content "Write parameter“. (Compare section 4.10, "Reading the reaction telegram with a read request").

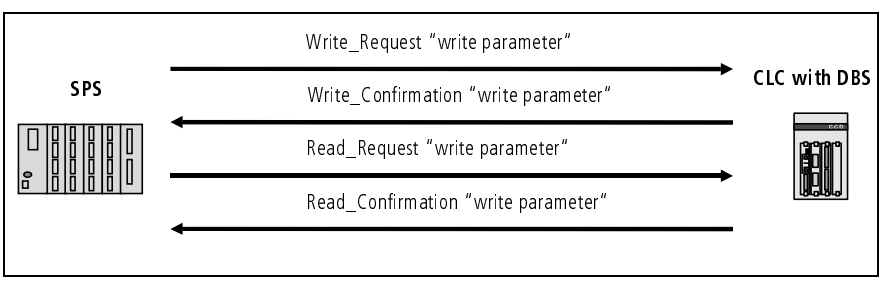


Fig. 6-4: Writing a parameter in the PCP channel

Example with PCP2.0 and G4 master:

Drive 1 writes the value 0 into the setup position 0 (A-0-0056).

1st step: The PLC sends the *Write_Request*.

0082	000C	Code for service Write_Request, Parameter_Count 12 words
0002	5E71	Invoke_ID, Communication_Reference, Index (=data exchange object)
0020	02D7	Subindex, Data_Length (5E71 = 32Byte), StZ, CS (compare SIS telegram)
0909	009F	DatL, DatLW, Cntrl, SIS service
0000	3C01	AdrS, AdrE (not evaluated), control byte, drive address
0138	0000	parameter type (A-0-0056) HW LB, LW LB, LW HB, parameter value HW LB
0000	00xx	parameter value HW HB, LW LB, LW HB

2nd step: The CLC sends *Write_Confirmation.*

8082	0002	Code for service Write_Confirmation, Parameter_Count 2 words
0002	0000	Invoke_ID, Communication_Reference, Result positive

3rd step: The PLC sends *Read_Request*.

0081	0003	Code for service Read_Request, Parameter_Count 3 words
0002	5E71	Invoke_ID, Communication_Reference, Index (=data exchange object)
0020	xxxx	Subindex, Data_Length (5E71 = 32Byte), -, -

4th step: The CLC sends *Read_Confirmation.*.

8081	0013	Read_Confirmation, Parameter_Count [words] = Länge von 5E71 + 3
0002	0000	Invoke_ID, Communication_Reference, Result positive
0020	020C	-, Data_Length (5E71 = 32Byte), StZ, CS (compare SIS telegram)
0303	109F	DatL, DatLW, Cntrl, SIS service
0000	003C	AdrS, AdrE (not evaluated), status byte, control byte,
01xx	xxxx	drive address

As a value of 0 is signalled in the status byte, A-0-0056 has been successfully written (compare sec. 4.10, "Protocol content (telegram content)").

Read parameter (SIS service 0x90)

To read a parameter on the CLC, the PLC first sends service *Write_Request* with SIS telegram contents "read parameter“ and then fetches the data with service *Read_Request* with the SIS telegram content "read parameter“. (Compare sec. 4.10, "Reading the reaction telegram with a read request").

6.7 DBS03 board hardware

Front view

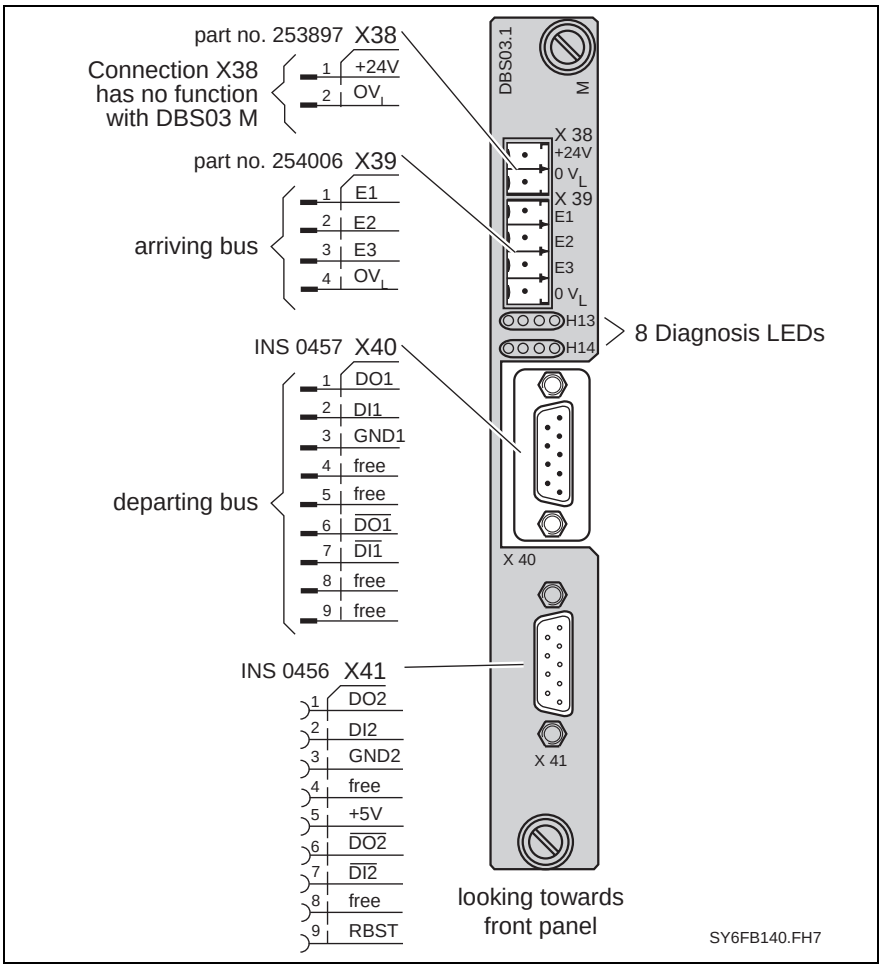


Fig. 6-5: Front view of the DBS03

DBS03 structure

The DBS03 board is conceived as a module which is directly plugged onto the control board CLC-D. Once it has been screwed onto the control board with three guide pins, it becomes a unit with the CLC-D which can only together be inserted in the drive or a separate CCD card rack.

Note: Additional boards can be plugged onto DBS03. This should be noted when dismantling or removing the card rack!

Power is supplied (+5V) by the drive or CCD card rack via a connector on the back. Signals are always exchanged via the connector to the CLC-D.

The interface to the CLC-D is a 68020bus. Only one DBS03 board can be used together with the CLC-D.

Note: The DBS03 board must not be operated together with an other fieldbus slave board.

The DBS03 board has the following interfaces:

Interface to the drive or CCD card rack

This interface is used to supply power to DBS03 board, if the CLC-D does not supply the power.

Interface to CLC-D or other card racks

Information is exchanged between CLC-D and other card racks via this interface. The interface is a 68020 bus interface with partial coding of the address space so that other card boards can also be mounted.

External power source

The DBS03 is **not** connected to a repeater function, i.e., no external supply voltage can be connected to a X38. Thus the Interbus ring is interrupted if the control voltage of the CLC and DBS is off.

Interbus - long-distance bus, incoming interface

Interbus-standard interface as per DIN E 19258 for long-distance bus participants via a 9-pin D-subminiature connector. The interface is completely galvanically isolated. It contains a duplex circuit based on an RS 485.

X40	Signal	Designation	X40	Signal	Designation
1	DO 1	Out RS 485	6	/DO 1	Out RS 485
2	DI 1	IN RS 485	7	/DI 1	IN RS 485
3	GND 1	reference potential	8	---	not used
4	---	not used	9	---	not used
5	---	not used	-	---	---

Fig. 6-6: Signal configuration X40, Interbus, incoming bus

Interbus - long-distance bus, outgoing interface

Interbus standard interface as per DIN E 19258 for long-distance via a 9-pin D-subminiature socket. The interface is completely galvanically isolated. It contains a duplex circuit based on the RS 485. A strobe signal to detect a relaying interbus is included.

X41	Signal	Designation	X41	Signal	Designation
1	DO 2	Out RS 485	6	/DO 2	Out Rs 485
2	DI 2	IN RS 485	7	/DI 2	IN RS 485
3	GND 2	reference potential	8	---	not used
4	---	not used	9	RBST	remote bus control
5	+5V 2		-		

Fig. 6-7: Signal configuration X41, Interbus, outgoing bus

Signal configuration X39, external inputs

The external inputs are not supported by the CLC-D.

DBS03 diagnoses

LED diagnoses on the front panel

The DBS03 panel has a total of 8 diagnostic LEDs on the front. These enable the diagnosing of states between the interbus ring and communication between the DBS03 board and CLC-D.

Arrangement of the diagnoses - LED

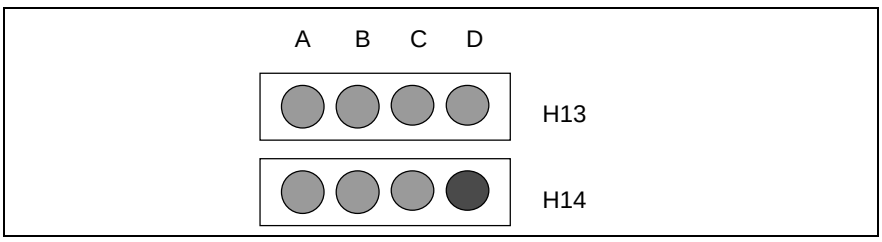


Fig. 6-8: LED diagnoses arrangement

LED diagnosis definitions

- H13A (green) **UL**
  Power source of INTERBUS - drive OK
  The power source comes from the 5V of DBS03 via the DC/DC converter and made available to the galvanically isolated bus drivers.
- H13B (green) **BA** Bus active
  INTERBUS process data transmission active
  This LED is always on if the master has activated his cyclical data traffic on the bus.
- H13C (green) **TR** Transmission active
  If PCP communication is done on the INTERBUS ring with this participant, then this LED is activated. PCP initialization and object structure reading are also evaluated as PCP communication (Get.OV).
- H13D (green) **RC** Remote Check
  This LED checks bus in the ring leading from this participant to the next. If this path is OK, then the LED is switched on. The LED is set with the initialization of the INTERBUS ring if detected that it is OK.
- H14A (green) **SW-RUN** Software RUN
  This LED is used with the LED H14C. It support the diagnosis of the correct software RUN and displays the successful synchronization between CLC-D and DBS03.
  If synchronization between CLC-D and DBS03 is corrected, then these LEDs flash alternately. A rhythmic flashing indicates a working INTERBUS interface but a faulty synchronization of the CLC.
- H14B (green) **+24 V** external +24V applied
  This LED is not used with DBS03 board.
- H14C (green) **SW-RUN** Software RUN
  See description on LED H14A.
- H14D (red) **RD** Remote-Bus disable
  This LED is on if the relaying bus is not working. Whether a relaying bus is mounted or not is detected by that board with the RBST signal which is connected to +5V via a relaying bridge. If a relaying cable is mounted, but the connection to the next participant has broken down, then this LED is switched on if the master runs his bus check.

7 The Fieldbus Interface DeviceNet

7.1 Introduction

Section 4 describes the basics that apply to all fieldbuses within SYNAX. This sections outlines the bus-specific features and functions of the DeviceNet.

The connection of SYNAX to DeviceNet uses the CLC plug-on card DCF01.

7.2 Functional features

Module DCF01 has the following features:

- DeviceNet Slave per ODVA specification 1.3
- DeviceNet – circuit with completely galvanically isolated interface. Uses a Phoenix connector.
- LED diagnostics field that corresponds to ODVA guidelines on the front panel.
- Freely configurable process data channel with 1 to 6 words data width at the BUS.
- Monitoring of both process data channel and Explicit Messages.
- Data exchange to control module CLC - D via the dual port memory.
- Hardware and software synchronization with control module CLC-D.
- Implementation of an object structure for simple accessing of variables and parameters of the control module and drive.
- Upload / download function via four array of 16 to 128 bytes implemented (Explicit Message).
- The module uses the predefined master/slave connection set and works as group only two server.

7.3 Setting baudrates, MAC-IDs and data formats

The device net baudrate is set via a SynTop dialog "CLC (host) communications basic settings".

The device net interface of the SynTop dialog "fieldbus - settings" should be used to specifiy MAC-IDs and data formats.

Baudrate DeviceNet permits baudrates of 125, 250 and 500 kbps. The rate is written via SynTop in parameter "DeviceNet - Baudrate" (C-0-0151). The default value is 125kbps (C-0-0151 = 125000).

MAC-ID The MAC-ID contains the participant address of the slave in DeviceNet. It is written via SynTop into parameter "fieldbus address" (C-0-0125). It must be set for a 2 to 63 range for DeviceNet.

Note: After executing the "load base parameters" command, the address in parameter "fieldbus address" (C-0-0125) reads: 99!

Data formats

The DeviceNet standard specifies the Intel format for data transmission. This can ause data format problems if the PLC is working with a Motorola processor and the master board has no knowledge of the data current structure.

For the DCF to be able to correct the data forms prior to relaying the data to the CLC, there are two possible data swapping settings:

- words in doubleword
- bytes in data exchange objects

SynTop can transmit both of these settings to bit 8 (words) and bit 9 (bytes) of parameter "fieldbus - control word" (C-0-0129).

Note: After executing the "load base parameters" command, both data format bits (swap bits) are deleted in parameter "fieldbus - control word" (C-0-0129). This corresponds to the setting with a master board that conforms to standards.

Data format configuration

DeviceNet communication between SYNAX and an

- SLC 5/04 (Allen Bradley PLC) and a
- scanner 1747 SDN (master board)

requires both exchange settings (words and bytes) because the PLC works with a Motorola processor and the scanner works with an Intel word machine.

Note: The setting of both SWAP bits depends on the PLC and master board. It must be empirically determined when implementing the DeviceNet interface.

7.4 Object Structure

Class, Instance and Attribute

The DeviceNet specification denotes the data of a unit by class, instance and attribute. The data for the PLC are configured either as polled I/O or it accesses the object with an Explicit Message using class/instance and attribute. The values for these are calculated as below:

$$class = 100 + (object\ no. - 0x5E70)/16$$

$$instance = (object\ no. \text{modulo} 16) + 1$$

$$attribute = 100$$

The DCF01 uses 8 bit values for class, instance and attribute. With class and attribute the values are greater or equal to 100 for manufacturer-specified data. Sixteen object numbers are compiled in one class. The object with the lowest object number (0x5E70, data exchange object with size of 16 bytes) is displayed on class 100, instance 1. The attribute that always enable the accessing of the data is always attribute 100.

The possible values for the attribute are:

- Attribute 100: data contents of object
- Attribute 101: length of the object (read only)
- Attribute 102: corresponding object number (index, read only)

Examples:

- Data module 101, element 1 equals object number 0x5E80. The data in DeviceNet corresponds to class 101, instance 1, attribute 100.
- Data module 101, element 16 equals object number 0x5E8f. The data in DeviceNet corresponds to class 101, instance 16, attribute 100.

Note: The number of the data module thus corresponds to the class in Device Net, the element number to the instance.

- The fieldbus status word with object number 0x5FF2 is read via DeviceNet with class 121, instance 3 and attribute 100.

Additional diagnostics objects

The DeviceNet interface supports additional diagnostics objects via the PLC.

Designation:	Object no.:	Type	Master access:	P D:
configuration Dword and byte swap	5E78	u16	R	no
Indramat SW release	5E79	u16	R	no
(Internal SW version)	5E7F	u16	R	no

Fig. 7-1: Additional diagnostics objects

7.5 Monitoring fieldbus transmission behavior with bus failure

As described in Sec. 4.5, "Monitoring fieldbus transmission" the DCF monitors bus behavior with a watchdog timer so that it can specifically respond to a bus failure.

Watchdog Function

The PLC indirectly sets watchdog time via an object during boot up. The slave uses this to recognize a bus failure.

The time set in [ms] is computed based on the object

class 5, instance 2, attribute 9: expected packet rate

and multiplied by 4.

The watchdog is switched off with 0 value.

Error reaction with bus failures

The DCF freezes the most recently received data in the event of a bus failure and deletes bit 3 in object ‘Status fieldbus’ (5FF2). This bit is displayed in operating mode on the CLC at output "fieldbus - real time channel active" (_A:C01.08). The user can use this bit in the I/O logic (VKL) for a specific error reaction.

With bus return, output "fieldbus - real time channel active" (_A:C01.08) is set.

7.6 Multiplex channel

The multiplex channel can only be used if there is data consistency over the entire data length.

Note: With SLC 5/04 with wcanner 1747 SDN, for example, the complete slave I/O range must be mapped in one segment.

The general features of the multiplex channel have already been described in section 4.7. This section decribes the bus-specific features of the multiplex channel with DeviceNet.

Bus-specific are

- the administration of the multiplex levels,
- bit assignment of the multiplex control and status words and
- the sequence in the multiplex channel with a level change.

Administering multiplex levels

In the case of multiplexing, the following indices are internally active with SYNAX

- the currently received data via the fieldbus entered in a data matrix (data direction PLC -> CLC) and
- the data to be sent copied out of the data matrix onto the bus (data directiom CLC -> PLC).

The administration of the data matrix and thus the multiplex index within SYNAX is only possible with DeviceNet on CLC. It is set via the SynTop dialog "fieldbus settings" (corresponds to bit 13 in "fieldbus - control word" (C-0-0129)).

Multiplex administration on the CLC

Multiplex administration on the CLC replaces the DATA_VALID bit with call back DATA_READY (bit 15 in the mutliplex status word, Fig. 7-2). DATA_READY acknowledges output data and fetches the input data on the CLC after a multiplex level change. The PLC can switch the multiplex level again as soon as the slave (the CLC) sets the DATA_READY bit.

Multiplex control / status word

Fig. 7-1 and Fig. 7-2 show bit assignment of multiplex control and status words.

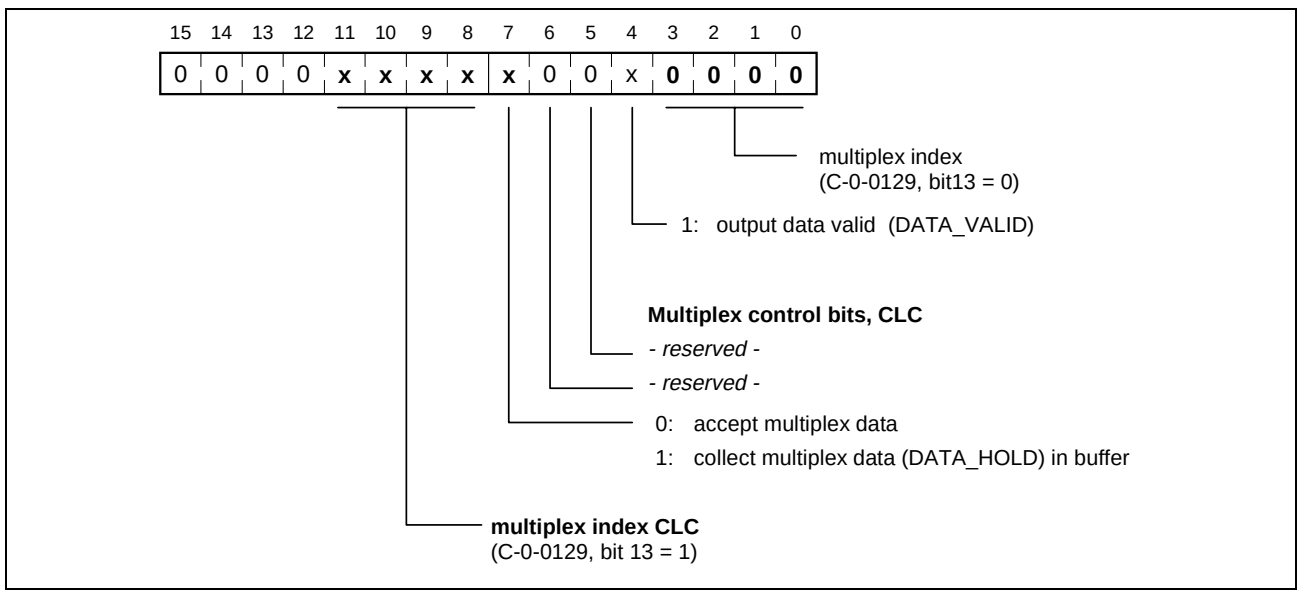

15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
0 0 0 0 x x x x x 0 0 x 0 0 0 0
multiplex index
(C-0-0129, bit13 = 0)
1: output data valid (DATA_VALID)
Multiplex control bits, CLC
- reserved -
- reserved -
0: accept multiplex data
1: collect multiplex data (DATA_HOLD) in buffer
multiplex index CLC
(C-0-0129, bit 13 = 1)

Fig. 7-1: Multiplex control word (with multiplex administration on the CLC)

Multiplex status word

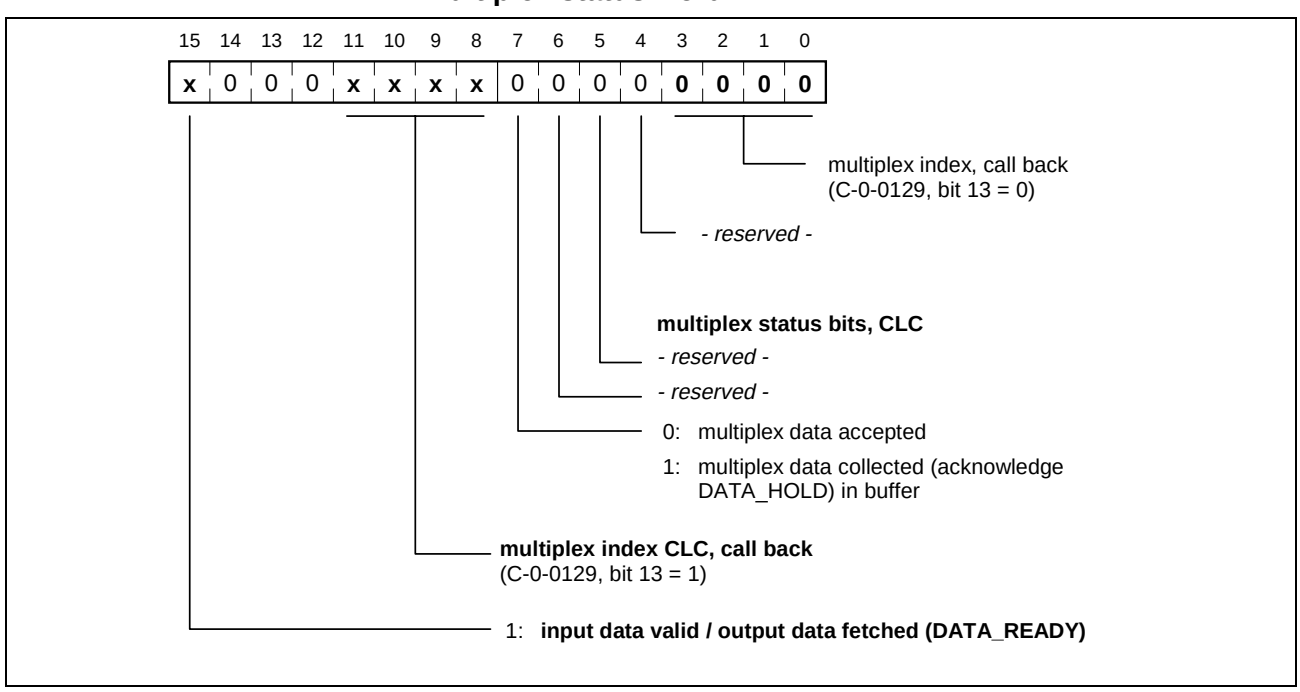

15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
x 0 0 0 x x x x 0 0 0 0 0 0 0 0
multiplex index, call back
(C-0-0129, bit 13 = 0)
- reserved -
multiplex status bits, CLC
- reserved -
- reserved -
0: multiplex data accepted
1: multiplex data collected (acknowledge DATA_HOLD) in buffer
multiplex index CLC, call back
(C-0-0129, bit 13 = 1)
1: input data valid / output data fetched (DATA_READY)

Fig. 7-2: Multiplex status word (with multiplex administration on the CLC)

Multiplex administration on the CLC means that the bits are defined as follows:

Multiplex index CLC

The PLC sets the index in the control word, CLC acknowledges the index in the status word.

DATA_HOLD, acknowledge DATA_HOLD

For command values transmitted over the course of several bus cycles and given changing multiplex levels it is possible to achieve data consistency with the DATA_HOLD bit in the control word. DATA-HOLD is acknowledged in the status word.

The data of several sequential transmission cycles are collected in the input buffer on the CLC. As long as the DATA_HOLD bit is set to "1", the buffer is not read out. Only after ther reset of DATA_HOLD will the new data be accepted in the relevant CLC parameters. New command values become simultaneously effective (in the same communication cycle).

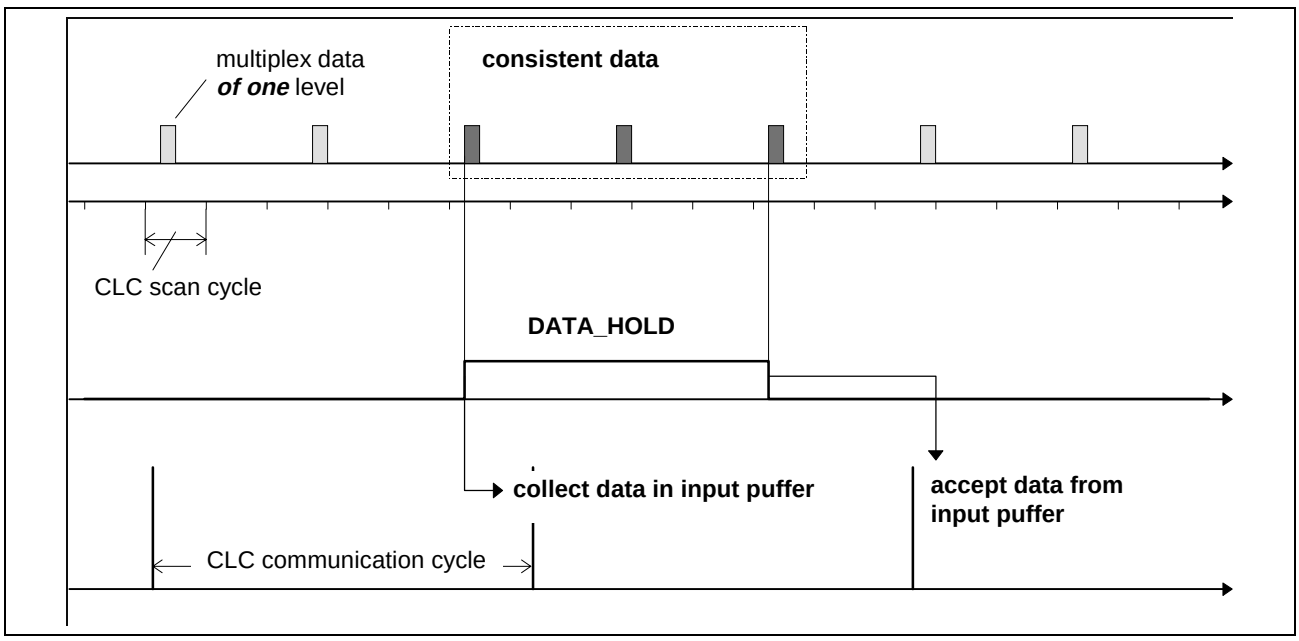


Fig. 7-3: Data consistency in the multiplex channel

DATA_VALID (Control word)

The master signals in the control word that the command value is valid. If only actual values are to be read, then DATA_VALID = 0 can be set.

DATA_READY (Status word)

The CLC signals that valid actual values for the master are available and the new command values have been fetched after a level change.

Given multiplex administration on CLC, bits 0-3 in control word (multiplex index) must be set to "0000", bits 0-3 in status word (multiplex index, call back) acknowledge "0000" and bit 4 status word has no meaning.

Sequence in multiplex channel with a level change

The level change in the multiplex channel is subsequently explained with multiplex administration on the CLC.

Output status

The PLC has a multiplex level n.

The DATA_VALID in control word is set if the CLC is to fetch command values.

The CLC acknowledges multiplex level n.

The CLC has set DATA_READY.

Step 1

The PLC sets random multiplex level m (whereby m <= multiplex depth).

The DATA_VALID in control word remains set if new command values for the CLC are sent and fetched by the CLC in the same fieldbus cycle .

Step 2

The PLC waits for the acknowledge of the multiplex level (e.g., XOR comparison in pairs of index bits).

Step 3

The CLC acknowledges level changes, sends the actual values of new levels, receives command values of new levels (collects command values if PLC DATA_HOLD is set) and acknowledges both actions with DATA_READY.

Step 4

The PLC fetches actual values of the CLC if it sends back the new level in the multiplex status word and DATA_READY is set. The level change is completed.

7.7 DCF01 board hardware

Front view of the DCF01

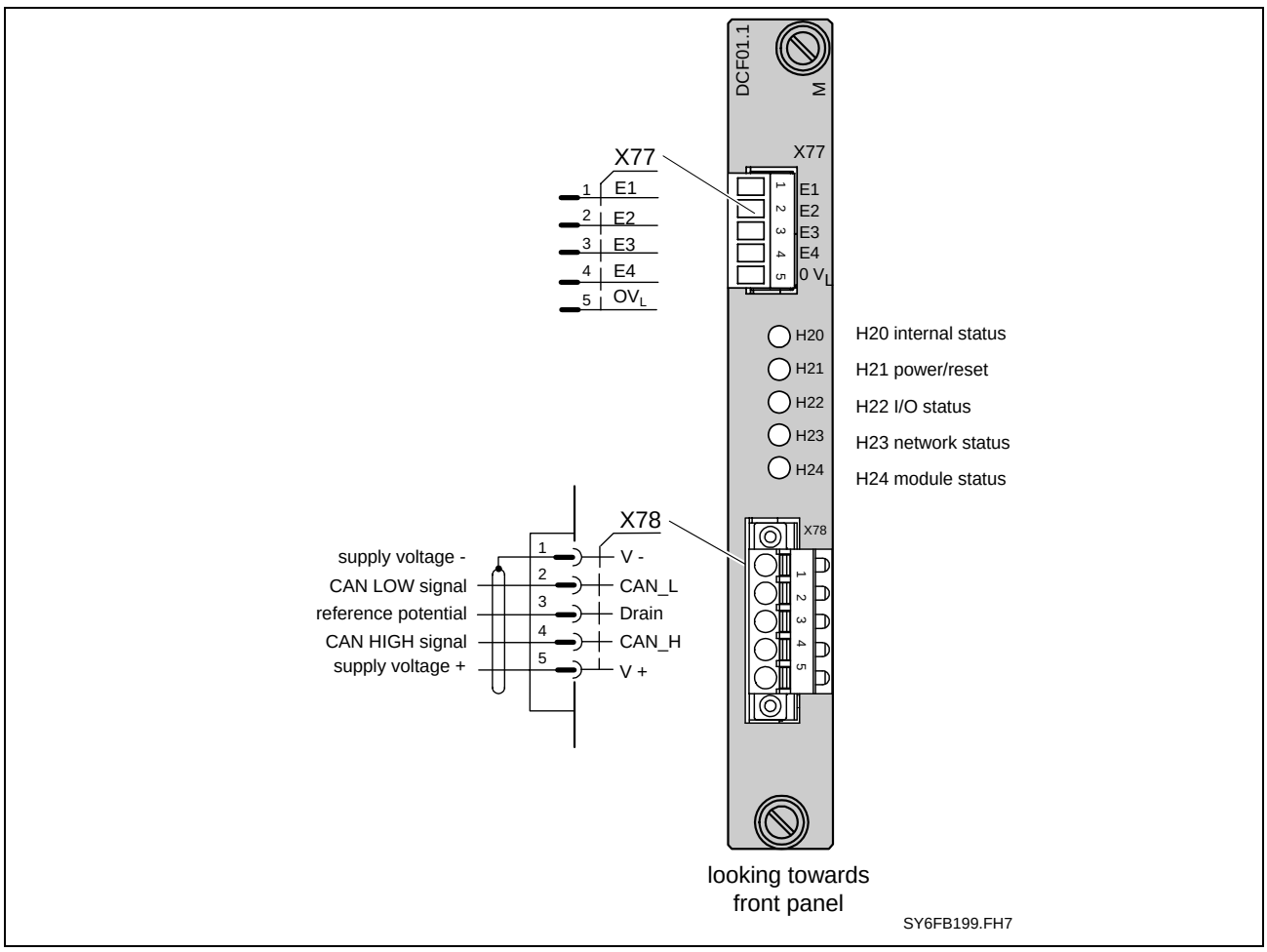


Fig. 7-4: Front view of the DCF01

Structure DCF01

The DCF01 board has been designed as a plug-in board for direct mounting to CLC-D control board. Once screwed into place with three guide pins it becomes one CLC-D unit. They can only be inserted together into the drive or a separate CCD card rack.

Note: Additional boards can be plugged onto the DCF01. This should be noted when dismantling or removing the card rack!

Power is supplied (+5V) by the drive or CCD card rack via a connector on the back of the DCF01. Signals are always exchanged with the CLC-D via the connector.

The interface to the CLC-D is a 68020 bus. Only one DCF01 board can be switched together with the CLC-D.

Note: The DCF01 may not be operated together with Profibus slave board DPF05 or the Interbus slave board.

The DCF01 has the following interfaces:

Interface to the drive or CCD card rack

This interface is used to supply power to the DCF01 board, if the CLC-D does not supply the power.

Interface to CLC-D or other card racks

Information is exchanged between the CLC-D and other card racks via this interface. The interface is a 68020 bus interface with partial coding of the address space so that other card boards can also be mounted.

External inputs

not supported

External power source

The transceiver of the DCF01.1 module receive power in accordance with the ODVA specification via the bus cable. This does not, however, mean that the entire unit is supplied via the bus. The CLC-D control only works if it is supplied with voltage separately.

DeviceNet interface

The DeviceNet interface is galvanically completely isolated in accordance with the ODVA specification via a Phoenix combicon 5 pin connector.

Signal configuration X78, DeviceNet

X78	Signal	Designation	Colour
1	V-	supply voltage	black
2	CAN_L	CAN LOW signal	blue
3	Drain	reference potential	blank
4	CAN_H	CAN HIGH signal	white
5	V+	supply voltage +	red

Fig. 7-5: Signal configuration X78, DeviceNet

Signal configuration X77, external inputs

The external inputs at X69 are not supported by the CLC-D.

Diagnoses DCF01

LED diagnoses on the front panel

The DCF01 panel has a total of 5 diagnostics LED on the front.These enable the diagnosing of states between the bus communication and the communication between board DCF01 and CLC-D.

LED diagnosis definitions

LED	Signal	Status	Definition
H20	**Internal status**	red	no synchronization with CLC-D
		off	synchronization with CLC-D successful
		green (pulse)	Explicit Message received
H21	**Power/Reset**	off	unit switched off or reset signal applied
		green	voltage supply OK
H22/IOS	**I/O Status**	off	all I/Os active
		green	outputs active and inputs valid
		green flashing	outputs inactive (no longer sent by master)
		red flashing	monitoring time exceeded with I/O link (timeout)
H23/NS	**Network status**	off	not online
		green flashing	online, but no connection to master
		green	online with connection to master
		red flashing	monitoring time exceeded with I/O link (timeout)
		red	critical link error (doubled MAC-ID or bus off)
H24/MS	**Module status**	off	unit switched off
		green	normal operation
		green flashing	configuration error
		red flashing	an error that can be cleared
		red	an error that cannot be cleared, replace card

Fig. 7-6: Definition of LEDs

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engineering
mannesmann
Rexroth

SYNAX

Decentralized System for the Synchronization of Machine Axes

Appendix C: Terminal

Indramat

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1 The Terminal

1.1 Starting up the CLC terminal

The following equipment is needed for starting up:

- an IKS 061 service cable
- and a personal computer with the terminal emulation program Procomm Plus (to a limited extent a VT-100 terminal can be used or some other terminal emulation program).

The IKS 061 service cable

The power to the CLC must be off when the PC and the VT-100 terminal are connected. The ready-made cable IKS 061 can be ordered from INDRAMAT. It facilitates connection. For further details, see the following figure:

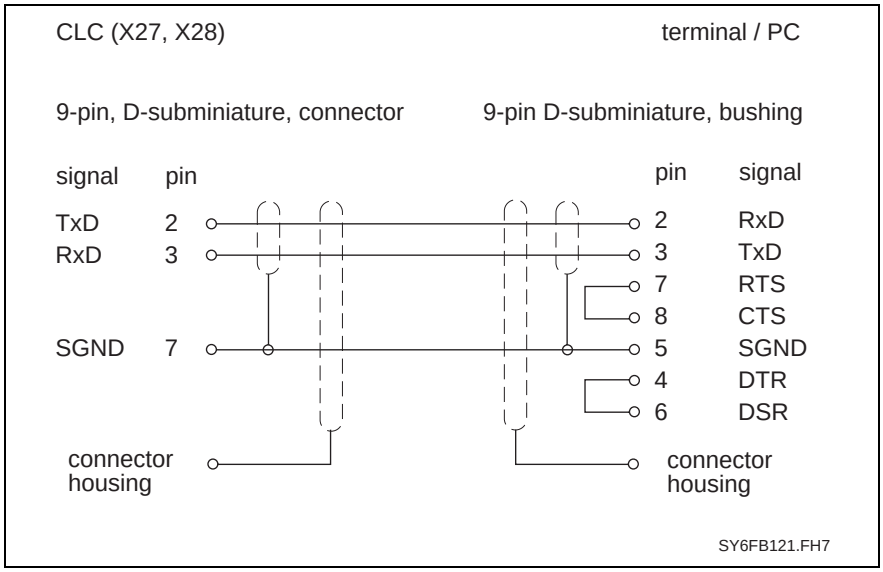


Fig. 1-1: Connecting a PC via the RS-232 interface on the CLC

Personal computer (PC)

The personal computer must be equipped with the following:

- it must be IBM compatible
- it must have a MS-DOS operating system
- there must be an RS-232 interface
- there must be hard drive for storing the parameters and
- emulation software for emulating the VT100 terminal must be installed.

The emulation software emulates a VT100 terminal. This makes the user interface stored on the CLC visible on the PC's monitor.

The use of the terminal emulation program Procomm Plus is recommended.

The terminal settings must correspond and be conducted in accordance with the terminal emulation program handbook guidelines.

VT100 terminal

The VT100 terminal represents the minimum hardware equipment needed to make visible and implement the user interface stored on the CLC.

It is not possible to electronically secure the data outside of the CLC if the VT100 terminal is used. The VT100 terminal has no storage capabilities.

How to handle the VT100 terminal used is outlined in the user guidelines of the relevant unit.

Required terminal settings

The following describes the settings of the VT100 terminal or the emulation program.

Parameters:	Set value:
terminal emulation	VT100
duplex	VOLL
software flow control (XON/XOFF)	ON
hardware flow control	OFF
line wrap	OFF
terminal width / line wrap	80 columns
scroll	ON
CR translation in/out	CR
BS translation (RXD)	do not erase
BS key definition (TXD)	BS
break length	350 millisec
enquiry (CNTRL-E)	OFF
EGA / VGA - underline	OFF
7 or 8 bit ANSI commands	7 bits
echo locally	NO
expand blank lines	YES
set tab symbol	YES
character pacing	3 to 1 milliseconds
line pacing	0/10 sec
Pace character	’0’
drop eigth bit	NO
ASCII download timeout	10 sec
CR translation (upload)	NONE
LF translation (upload)	NONE
CR translation (download)	NONE
LF translation (download)	NONE
transmission rate	9600 Baud
parity	NONE
data bits	8
stop bit	1

Fig. 1-2: Required terminal settings

1.2 Terminal: Menu structure and functions

- The CLC and all connected drive controllers are mounted, electrically connected and tested.
- The power and feedback cables of all drives are attached to the drive controllers.
- The CLC is connected with all drive controllers via the fiber optic cable ring.
- The drive addresses of the connected drive controllers are set in rising order starting with 1.
- The personal computer or the VT100 terminal is connected via an IKS061 service cable to the CLC. Generally, the CLC user interface signals at terminal X27.
- If jumper S1 or I5 (at CLC-P02) is bridged and jumper S2 or I6 (at CLC-P02) is empty, then terminal X27 of the CLC must be used for the terminal.
- If jumper S1 or I5 (at CLC-P02) is empty and jumper S2 or I6 (at CLC-P02) is bridged, then terminal X27 of the CLC must be used for SynTop.
- The terminal emulation program starts (only with PCs).

Note: It is possible to apply functions to the serial interfaces via the parameters. Those must be used which exclude implementation as a service interface.

To set up communications with the CLC terminal interface, it may be necessary, in some cases, to take the following steps:

Jumper S1 or I5 (at CLC-P02) bridged, jumper S2 or I6 (at CLC-P02) empty:
⇒ CLC terminal interface signalling at X27

Jumper S1 or I5 (at CLC-P02) empty, jumper S2 or I6 (at CLC-P02) bridged:
⇒ SynTop signalling its presence at X27

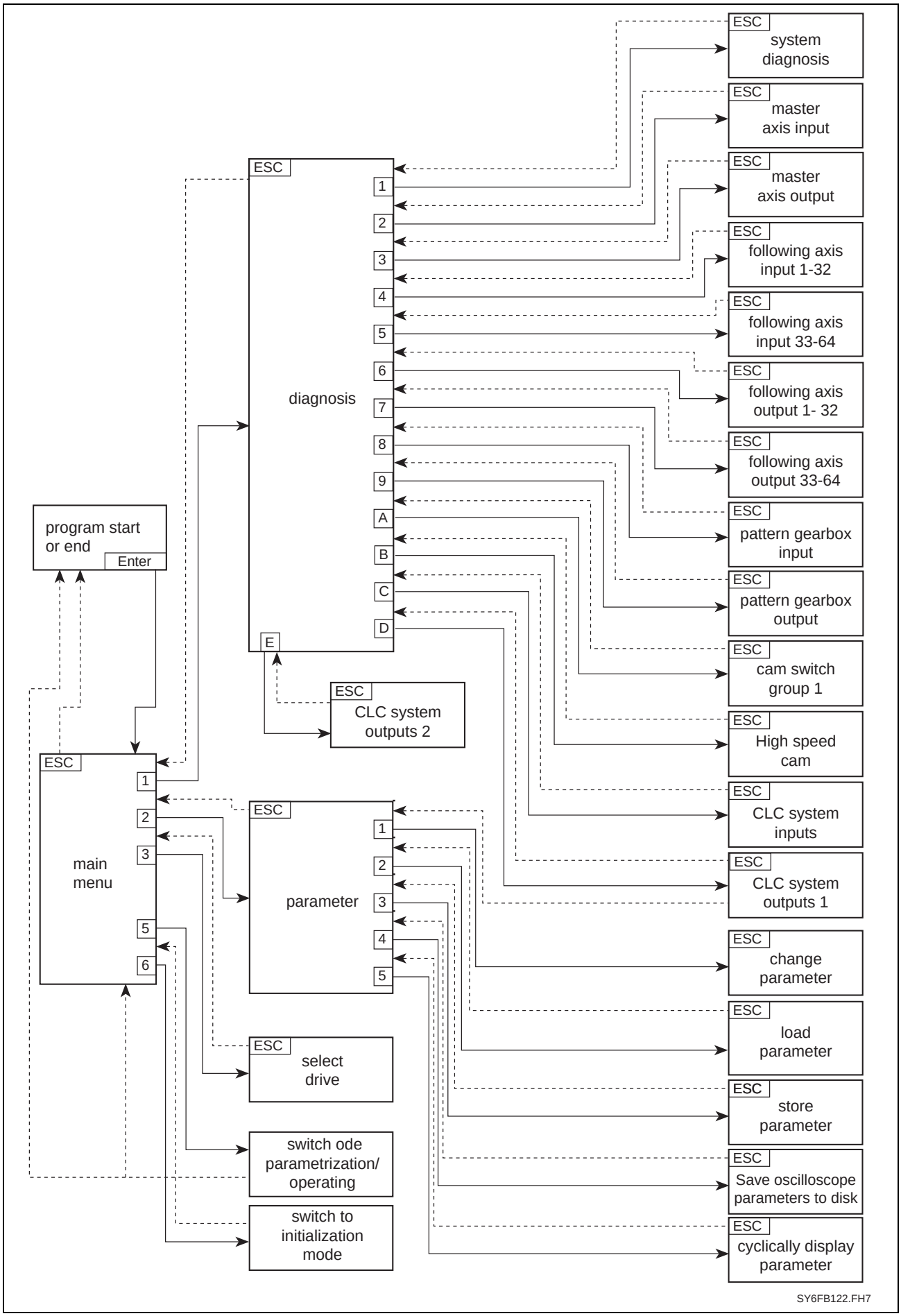


Fig. 1-3: Function levels of the CLC user interface

Handling of the parametrization and diagnostics programs

After creating the proper conditions (see "Terminal: Menu structure and functions", page 1-3), then proceed as follows:

Switch control voltage on via the power supply module (see Applications Description of the Power Supply Unit). The parametrization and diagnostics program stored on the CLC emits the following message:

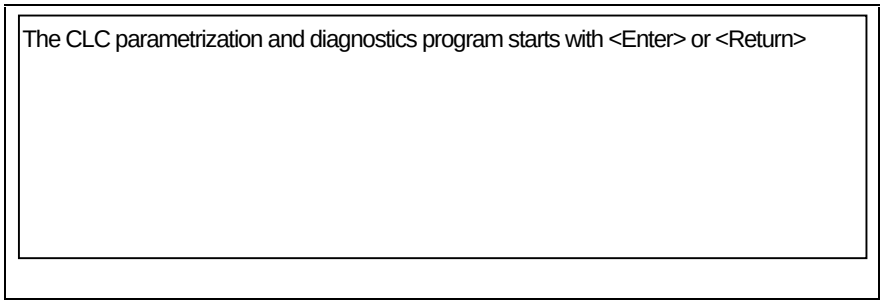


Fig. 1-4: The ready message of the CLC user interface

The program is started with <Enter> or <Return>. The main menu then appears.

Submenus can be accessed with keys (see Fig. 1-2).

The current drive can be selected in the submenu using the F2 key.

Submenu "load parameters"

The "load parameters" menu is only available in parametrization mode.

When in this menu, it is possible to load the parameters from the hard drive of a PC. After the "load" key was pressed, the following occurs:

Press the <Page Up> key

- This informs the terminal emulation program that a file is being transmitted from the hard drive to the serial interface (CLC).

Select "ASCII" in upload menu

- A selection menu of the terminal emulation program appears. The file format "ASCII" must now be selected.

Input file name and <Return>

- Once the file name has been input and confirmed with <Enter>, the terminal emulation program transmits the selected file to the CLC via the serial interface.

Note: Pressing the <Return> key (see previous SYNAX doc.) has been dropped. With activation of "load parameter", the CLC automatically goes into receiving mode. The change is compatible with previous versions, i. e. hitting the return as the first step of load parameter will not disrupt operations.

Submenu "save parameters"

The menu "save parameters" is only available in parametrization mode. parameters can be stored on the hard drive of a PC with it.

Selecting the drive(s)

- The cursor is moved with the cursor key. It is possible to select all drives or a specific drive using the space bar.
- The selected drive is marked with an "X".

Selecting parameter groups

- One or several parameter groups must now be selected which are to be stored.
- If the **A parameters** are selected, then the A parameters of the selected drives are stored.
- If the **S/P parameters** are selected, then the S/P parameters of the selected drives are stored.
- If the **C parameters** are selected, then the C parameters of the CLC are stored. The choice of drives is irrelevant in this case.

Start transmission

- Transmission is started with the return.

Submenu "save parameters"

Press <Page Down>

- This informs the terminal emulation program that a file is to be transmitted to the hard drive from the serial interface (CLC).

Select "ASCII" in download menu

- A selection menu of the terminal emulation program appears in which the file format "ASCII" is selected.

Input file name and <Return>

- After the file name is input and confirmed with <Return>, the terminal emulation program is in a ready state.

Start transmission with <Return>

- After <Return> is entered, the CLC sends the parameters to the terminal emulation program via the serial interface. The program writes the data onto the hard drive.

Editing list

There are parameters in the CLC system which are made up of more than one element. These parameters are called a list.

These lists have a maximum number of elements. This number may not be exceeded.

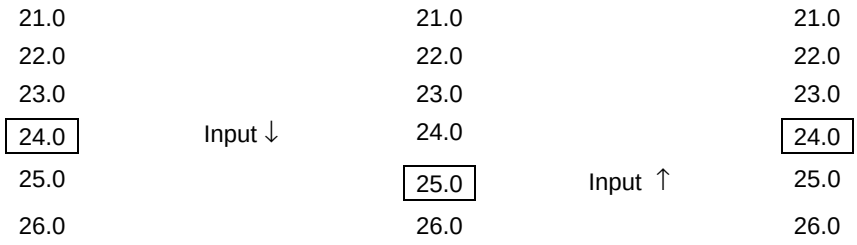
Each lis has a programmable number of elements. This specifies how many elements of a lis can actually be written into. Values not written into are identified with '*' in the following.

The edit window

One element is depicted in the editing window of the display field of the CLC terminal. Using keys ↓ and ↑ moves this window within the list.

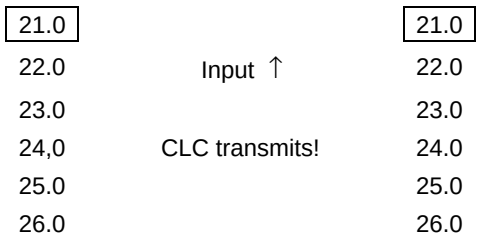
In the following, the edit window is highlighted with a frame.

Example: List with 6 elements (21.0, 22.0, 23.0, 24.0, 25.0, 26.0)

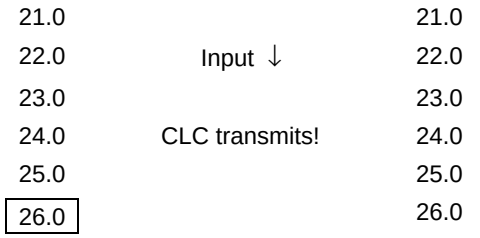


The element visible in the editing window can be edited like any other parameter.

If the editing window is on the first element, then the key ↑ will have no effect.



If the editing window is on the last possible element, then the key will have no effect ↓ :



If the editing window is on the last programmable element, then the key ↓ will have no effect:

21.0		21.0
22.0	Input ↓	22.0
23.0		23.0
*	CLC transmits!	*
*		*
*		*

Cancelling a list element

With <Shift/Del> the element visible in the editing window is cleared. Any following elements will move up.

Example: List with 6 elements (21.0, 22.0, 23.0, 24.0, 25.0, 26.0)

21.0		21.0		21.0
22.0		22.0		22.0
23.0		23.0		23.0
24.0	Input	24.0	Input	24.0
25.0	<STRG/L>	25.0	<STRG/L>	*
26.0		*		*

The list depicted in the example only has four programmable elements left after this step.

If the final element was cleared, then <STRG/L> has no effect:

21.0		21.0
22.0	Input	22.0
23.0	<STRG/L>	23.0
24.0		24.0
*		*
*	CLC transmits!	*

Inserting a list element

With <STRG/E> a new element without content is inserted in front of the element visible in the editing window. Any following elements move up one position.

Example: List with 3 elements (21.0, 22.0, 23.0)

21.0		21.0		21.0		21.0
22.0		22.0		22.0		22.0
23.0	Input		Input		Input	
*	of	23.0	of	0.0	of	0.0
*	<STRG/E>	*	<STRG/E>	23.0	<STRG/E>	0.0
*		*		*		23.0

The list used in the example has only six programmable elements after this step.

If the programmed length of the lis is equal to the maximum length, then the key <STRG/E> has no effect:

21.0		21.0
22.0	Input	22.0
23.0	<STRG/L>	23.0
24.0		24.0
25.0		25.0
26.0	CLC transmits!	26.0

1.3 The structure of the parameter files

Files are produced when storing CLC parameters. The following describes their structure.

A parameter file is made up of one or several management sections and the data blocks (usable data). Only ASCII symbols from IBM (MS-DOS) are used in the parameter file. Every line is concluded with <CRLF>.

Parameters file management

A management section of a parameter file is made up of five lines. Every line must be concluded with <CRLF>.

The first line must include "SERCOS-ASCII".

The fifth line includes the drive address set on the hardware of the drive. The drive address is made up of two symbols and must be located within the range 01 to 99.

Lines 2, 3 and 4 (free lines) are available for use by the user. They may have no more than a maximum of 60 symbols. If data from the CLC controller card is stored, then the CLC will enter the symbol <*> 12 times in the lines 3 and 4. In the line 2 the CLC writes the firmware version. When using the free lines, the user can later program these as needed.

Structure of the management section

SERCOS-ASCII

<free line>

<free line>

<free line>

<drive address>

The CLC creates the following management section when storing the parameter files:

Structure of the CLC management section:

SERCOS-ASCII

CLC*DP-SY*-03V08

****

****

<drive address>

These management setions can occur several times in one parameter file. A management section of this kind appears in front of

- every A parameter set for an axis
- every S/P parameter set for an axis and

every C parameter set.

Parameters file data blocks

A data block is always made up of one pipe, the identification number, the name, the attribute and the operating data (parameter). Depending upon the type of data, there an be one unit and one minimum or maximum input value.

Data block structure

Element 0	|	[start identifier, ASCII-Code = $(7C)_h$ or 124]
Element 1	<Ident number>	[see i.d. number structure]
Element 2	<Name>	[operating data name, max. 60 symbols]
Element 3	<Attribute>	[see attribute structure]
Element 4	<Unit>	[operating data unit, max. 12 symbols]
Element 5	<Min. Input value>	[depicted similar to the operating data]
Element 6	<Max. Input value>	[depicted similar to the operating data]
Element 7	<operating data>	[see operating data structure]
—		[element not in data block]

Identification number structure

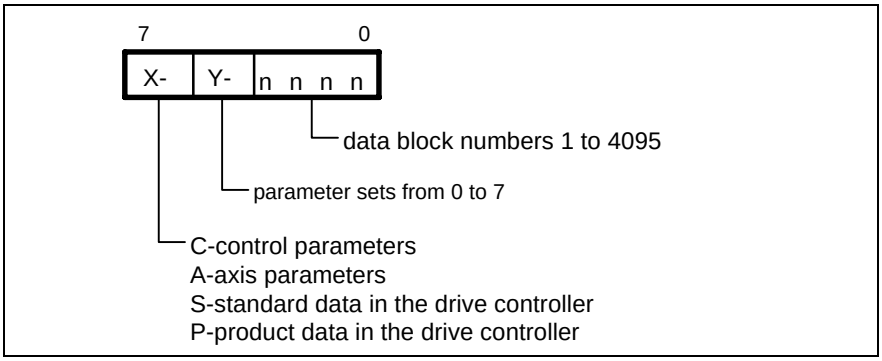


Fig. 1-5: Identification number structure

Structure of the attribute

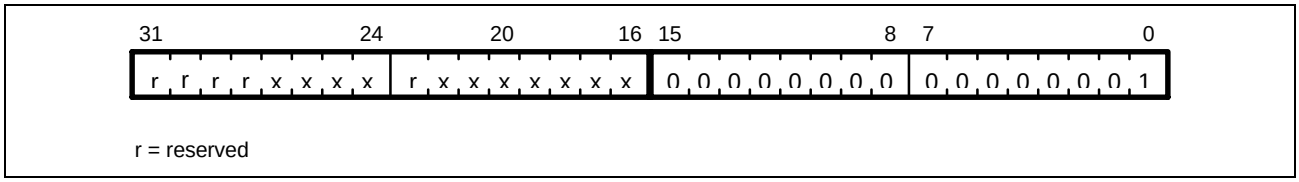


Fig. 1-6: Structure of the attribute

Bit 15 - 0: Evaluation factor

The evaluation factor is an integer without qualifying sign. It must be set on 1.

Bit 18 - 16: Data length

0 0 0 - reserved

0 0 1 - data is 2 bytes long

0 1 0 - data is 4 bytes long

0 1 1 - reserved

1 0 0 - data has a variable length with 1 byte data

1 0 1 - data has a variable length with 2 byte data

1 1 0 - data has a variable length with 4 byte data

1 1 1 - reserved

Bit 19: Function

0 - operating data or parameters

1 - command

Bit 22 - 20: Data type and display format

Data type	**Display format**
0 0 0 - binary number	binary
0 0 1 - no qualifying sign, whole number, decimal without qualifying sign	
0 1 0 - whole number	decimal with qualifying sign
0 1 1 - no qualifying sign, whole number, hexideicmal	
1 0 0 - ASCII symbol	Text (MS-DOS)
1 0 1 - no qualifying sign, whole number, identification number	
1 1 0 - reserved	
1 1 1 - reserved	

Bit 27 - 24: Places behind the decimal point

0 0 0 0 - no places behind the decimal point

...

1 1 1 1 - 15 places behind the decimal point (maximum)

Structure of the operating data

The operating data has a length of either

- 2 bytes, 4 bytes or

- a variable length of 0 to 65532 bytes.

If the length if variable, then the first and second bytes contain the length of the operating data.

The third and fourth bytes contain the length available to either the drive or the CLC for this operating data. The data start with the fifth byte.

Example of a management section:

SERCOS-ASCII

CLC*DP-SY*-03V08

****

****

01

Example of a data block with operating data 4 bytes long:

|
P-0-0061
angle display start table
00000100001000100000000000000001
degree
—
—

-38.000

Example of data block with operating data of variable length:

|
C-0-0013
I/O - allocation to internal/external I/O
01000000001101010000000000000001
--
--
--

01820	(actual length)
20000	(maximum length)
0x0007	PARA.EXE versions number)
0x0000	PARA.EXE release number)
0x002E	(OPCODE offset)
0x6331	(start VKLfile name:)
0x335F	("c13-dea8.txt,")
0x6465	
0x6138	
0x2E74	
0x7874	
0x2C20	
0x3039	(start of date VKLfile:)
0x2E30	("09.02.98,")
0x322E	
0x3938	
0x2C20	
0x3137	(start of time VKL file:)
0x3A35	("17:58,")
0x382C	
0x2043	(display selected HW platform)
0x4C43	("CLC\h\o")
0x0A00	
0x7000	(start VKL instructions...)
0x7200	
...	

1.4 Fault clearance

This section outlines fault clearance in terms of commonly occuring problems.

Fault	Cause	Action
user interface does not respond	service cable defective	check able, type IKS061
	interface incorrect or terminal set to PC	check the setting (⇒ C-0-0104)
	interface parameter on CLC incorrect	check both interfaces X27 / X28. Set Jumper S1 or I5 (at CLC-P02). Switch on again 1 The terminal signals on CLC interface X27. **or** Set Jumper S2 or I6 (at CLC-P02). Switch on again. SynTop communication via X27 with the CL correct parameters C-0-0011 C-0-0012 C-0-0033 C-0-0038 C-0-0104
CLC does not signal after phase reset (SynTop or terminal).		Check both interfaces X27 / X28. Set Jumper S1 or I5 (at CLC-P02). Switch on again. Terminal signalling on CLC interface X27. **or** Set Jumper S2 or I6 (at CLC-P02). Switch on again SynTop communicates with X27 with CLC. Correct parameters: C-0-0011 C-0-0012 C-0-0033 C-0-0038 C-0-0104

Fig. 1-7: Fault clearance table

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